GLE v4.0

# Graphics Layout Engine

## User Manual (v. 4.0.13)

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`http://www.gle-graphics.org/`

11 September 2007

# Contents

# Chapter 1

# Preface

## Abstract

GLE (Graphics Layout Engine) is a graphics package for scientists, combining a user-friendly scripting language with a full range of facilities for producing publication-quality graphs, diagrams, posters and slides. GLE provides LaTeX quality fonts together with a flexible graphics module which allows the user to specify any feature of a graph. Complex pictures can be drawn with user-defined subroutines and simple looping structures. Current output formats include EPS, PS, PDF, JPEG, and PNG.

### Trademark Acknowledgements

The following trademarks are used in this manual.

| | |
|---|---|
| Windows | Microsoft Corporation. |
| TeX | Donald E. Knuth, A Typesetting System. |
| LaTeX | Leslie Lamport, A Document Preparation System. |
| PostScript | Page Description Language, Adobe Systems Inc. |

### Typographic Conventions

The following conventions will be used in command descriptions:

| | |
|---|---|
| [option] | Specifies an optional keyword or parameter, the brackets should not be typed. |
| option1 \| option2 | Pick one of the options listed. |
| keyword | Keywords are represented in a bold typewriter font. |
| *exp,x,y,x1,y1* | Represent numbers or expressions. E.g. 2.2 or 2*5. Parameters to be entered by the user are given in italics. |

### Pathways

For those in a hurry:

1. Read chapter 1, The GLE Tutorial (beginners only).

2. Examine the examples at `http://www.gle-graphics.org/examples/`.
3. Browse through Chapter 3, The Graph Module.

For those with time:

- **Chapter 2, GLE Tutorial:** Covers installation and drawing a simple graph, highly recommended if you have never used GLE before.
- **Chapter 3, GLE Primitives:** Describes the commands used for creating diagrams and slides and for annotating graphs.
- **Chapter 4, The Graph Module:** Describes the commands for drawing graphs.
- **Chapter 5, The Key Module:** Describes the commands for producing keys for graphs.
- **Chapter 6, Advanced features of GLE:** Covers advanced features of GLE. This includes programming constructs, the LaTeX interface, ...
- **Chapter 7, Surface and Contour Plots** Describes the commands for drawing three-dimensional graphs.
- **Chapter 8, GLE Utilities:** Describes FITLS and MANIP.

# Chapter 2

# Tutorial

## 2.1 Installing GLE

This tutorial assumes that GLE is correctly installed. Information about how to install GLE can be found at the following URLs and in Appendix A.4 of this document. The GLE distribution also includes a README with brief installation instructions.

- Installation on Windows: `http://www.gle-graphics.org/tut/windows.html`.
- Installation on Linux: `http://www.gle-graphics.org/tut/linux.html`.
- Installation on Mac OS/X: `http://www.gle-graphics.org/downloads/mac.html`.

Feel free to post any questions or comments you might have about installing GLE on the GLE mailing list, which is available here:

- Mailing list: `https://lists.sourceforge.net/lists/listinfo/glx-general`.

## 2.2 Running GLE

GLE is essentially a command line application; this tutorial will show you how to run it from the command prompt. GLE can also be run from your favorite text editor or from QGLE, GLE's graphical user interface. More information about running GLE from a text editor is given in the installation instructions.

On Windows, you run GLE from the Windows Command Prompt. Normally the GLE installer should have added an entry labeled "Command Prompt" to GLE's folder in the start menu. On Unix-like operating systems, GLE runs from an X-terminal, such as "konsole" on Linux / KDE.

Once you have opened the command prompt or terminal, try running GLE by entering the following command.

```
gle
```

As a result, GLE displays the following message.

```
GLE version 4.0.13
Usage: gle [options] filename.gle
More information: gle -help
```

If this message does not appear and you see an error message instead, then GLE is not correctly installed. Refer to the installation instructions (Appendix A.4) for more information. In the following, we will show how to construct a simple drawing with GLE.

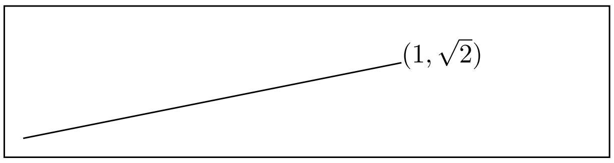


Figure 2.1: Result of your first GLE script.

## 2.3 Drawing a Line on a Page

Let's start with drawing a line on the page. GLE needs to know the size of the drawing you whish to make. This is accomplished with the size command:

```
size  8 2
```

This specifies that the output will be 8cm wide and 2cm high. Next we define a "current point" by moving to somewhere on the page:

```
amove 0.25 0.25
```

The origin (0,0) is at the bottom left hand corner of the page. Suppose we wish to draw a line from this point 5 cm across and 1 cm up:

```
size  8 2
amove 0.25 0.25
rline 5 1
```

This is a **relative** movement as the x and y values are given as distances from the current point, alternatively we could have used **absolute** coordinates:

```
size  8 2
amove 0.25 0.25
aline 5.25 1.25
```

To draw some text on the page at the current point, use the write command:

```
 write "Hi there"
```

Or, alternatively, you could include arbitrary LaTeX expressions using the tex command:

```
tex "$(1,\sqrt{2})$"
```

Now we have constructed complete GLE script, which looks as follows:

```
size 8 2 box
amove 0.25 0.25
rline 5 1
tex "$(1,\sqrt{2})$"
```

Enter the above GLE script using a text editor and save it to disk (any editor that saves in UTF8 or ASCII format will work). The following assumes that you have saved the file under the name "`test.gle`" in the folder `C:\GLE` on Windows, or `/home/john/gle` on a Unix-like operating system. Now open a command prompt and go to the folder where you saved the file. Then, run GLE on the file.

On Windows, you do this as follows (`C:\>` is the prompt):

```
C:\> cd C:\GLE
C:\GLE> gle test.gle
```

Or on Unix:

```
cd ~/gle
gle test.gle
```

GLE produces by default an Encapsulated PostScript (.eps) file:

```
     GLE 4.0.13 [test.gle]-C-R-[test.eps]
```

Try viewing the resulting "`test.eps`" with a PostScript viewer such as GhostView, and compare it to the output shown in Fig. 2.1. You can also preview it with QGLE, GLE's graphical user interface. After you've started QGLE, enter the following command at the command prompt.

```
gle -p test.gle
```

This will preview the output in the QGLE previewer window. GLE can also create PDF files. This is accomplished by setting the output device to "pdf".

```
gle -device pdf test.gle
```

Try viewing the resulting "`test.pdf`" with Acrobat Reader or similar. Other output formats supported by GLE (eps, ps, pdf, svg, jpg, png, x11) can also be obtained with the -device command line option (which can be abbreviated to -d). For example, to create a JPEG bitmap file, one can use:

```
gle -d jpg -r 200 test.gle
```

Help about the available command line options can be obtained with:

```
gle -help
```

and to obtain more information about a particular option, use:

```
gle -help option
```

The following command line options are supported by GLE:

```
 -help           Shows help about command line options
 -info           Outputs software version, build date, GLE_TOP, GLE_BIN, etc.
 -verbosity      Sets the verbosity level of GLE console output
 -device         Selects output device(s)
 -r              Sets the resolution for bitmap import/export and PDF output
 -fullpage       Selects full page output
 -output         Specifies the name of the output file
 -preview        Previews the output in the QGLE
 -gs             Call ghostscript for previewing
 -version        Selects a GLE version to run
 -compatibility  Selects a GLE compatibility mode
 -calc           Runs GLE in "calculator" mode
 -tex            Indicates that the script includes LaTeX expressions
 -inc            Creates an .inc file with LaTeX code
 -texincprefix   Adds the given subdirectory to the path in the .inc file
 -mkinittex      Creates "inittex.ini" from "init.tex"
 -nocolor        Forces grayscale output
 -nomaxpath      Disables the upper-bound on the drawing path complexity
```

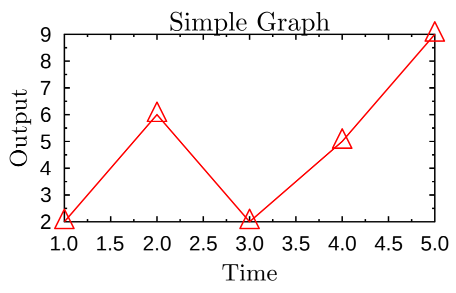
## 2.4 Drawing a Simple Graph

This section shows how to go about drawing a simple graph. Enter the following data in a new file and save it as "test.csv". Note that you can export files in CSV (comma separated values) format with most spread sheet programs.

```
1,2
2,6
3,2
4,5
5,9
```

The data is in two columns with a comma separating each column of numbers. The following commands will draw a simple line graph of the data.

```
size 7 4
begin graph
   title  "Simple Graph"
   xtitle "Time"
   ytitle "Output"
   data   "test.csv"
   d1 line marker triangle color red
end graph
```

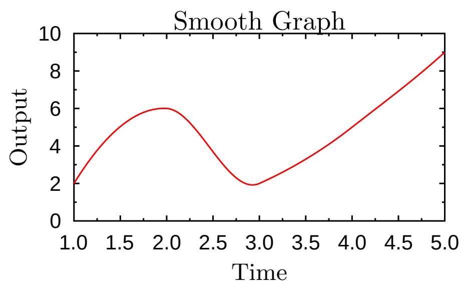


The commands title, xtitle, and ytitle specify the graph title and the axis titles. The command data loads the data file and the d1 command specifies how the first curve on the graph should look like. These commands are discussed in detail in Chapter 4. Possible values for the marker option can be found on the GLE wall reference chart in Appendix A.8.

The axis ranges can be specified with xaxis min $v_0$ max $v_1$ and yaxis min $v_0$ max $v_1$. A smooth line can be drawn through the data points by changing the d1 command to: d1 line smooth as in the following example.

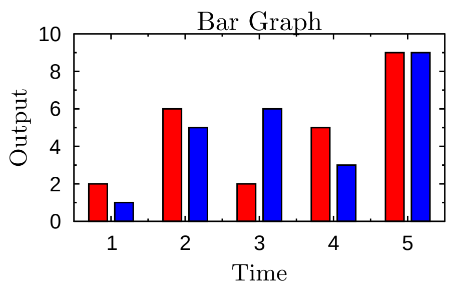
Note that the order of the commands is not important, except that circle is a parameter for the option marker and therefore must come right after it. The same holds for line and smooth and color and blue in the example “d1 marker circle line smooth color blue”.

```
size 7 4
begin graph
   title  "Smooth Graph"
   xtitle "Time"
   ytitle "Output"
   data   "test.csv"
   yaxis min 0 max 10
   d1 line smooth color red
end graph
```



It is simple to change to a bar graph and include last year’s measurements:

```
size 7 4
begin graph
   title  "Bar Graph"
   xtitle "Time"
   ytitle "Output"
   data   "year-2000.csv"
   data   "year-2001.csv"
   yaxis min 0 max 10
   bar d1,d2 fill red,blue
end graph
```



Adding min and max values on the axis commands is highly recommended because by default GLE won’t start from the origin unless the data happens to be very close to zero. It is also difficult to compare graphs unless they all have the same axis ranges. More information about the graph module is available in Chapter 4.

# Chapter 3

# Primitives

A GLE command is a sequence of keywords and values separated by white space (one or more spaces or tabs). Each command must begin on a new line. Keywords may not be abbreviated, the case is not significant. All coordinates are expressed in centimetres from the bottom left corner of the page.

GLE uses the concept of a **current point** which most commands use. For example, the command aline 2 3 will draw a line from the **current point** to the coordinates (2,3).

The current graphics state also includes other settings like line width, colour, font, 2d transformation matrix. All of these can be set with various GLE commands.

## 3.1 Graphics Primitives (a summary)

! *comment*
@*xxx*
aline *x y* [arrow start] [arrow end] [arrow both] [curve $\alpha 1$ $\alpha 2$ *d1 d2*]
amove *x y*
arc *radius a1 a2 [arrow end] [arrow start] [arrow both]*
arcto *x1 y1 x2 y2 rad*
begin box [fill *pattern*] [add *gap*] [nobox] [name *xyz*] [round *val*]
begin clip
begin name
begin origin
begin path [stroke] [fill *pattern*] [clip]
begin rotate *angle*
begin scale *x y*
begin table
begin tex
begin text [width *exp*]
begin translate *x y*
bezier *x1 y1 x2 y2 x3 y3*
bitmap *filename width height* [type *type*]
bitmap_info *filename width height* [type *type*]
box *x y* [justify *jtype*] [fill *color*] [name *xxx*] [nobox] [round *val*]
circle *radius* [fill *pattern*]
closepath
curve *ix iy* [*x1 y1 x y x y ... xn yn*]*ex ey*
define marker *markername subroutine-name*
ellipse dx dy [options]

elliptical_arc dx dy theta1 theta2 [options]
for *var* = *exp1* to *exp2* [step *exp3*] *command [...]* next *var*
grestore
gsave
if *exp* then *command [...]* else *command [...]* end if
include *filename*
join *object1.just sep object2.just* [curve $\alpha 1$ $\alpha 2$ *d1 d2*]
margins *top bottom left right*
marker *marker-name* [*scale-factor*]
orientation *o*
papersize *size*
postscript *filename.eps width-exp height-exp*
print *string$* ...
psbbtweak
pscomment *exp*
rbezier *x1 y1 x2 y2 x3 y3*
return *exp*
reverse
rline *x y* [arrow end] [arrow start] [arrow both] [curve $\alpha 1$ $\alpha 2$ *d1 d2*]
rmove *x y*
save *objectname*
set arrowangle angle
set arrowsize size
set cap butt — round — square
set color *col*
set dashlen *dashlen-exp*
set fill *fill color/pattern*
set font *font-name*
set fontlwidth *line-width*
set hei *character-size*
set join mitre — round — bevel
set just left — center — right — tl — etc...
set lstyle *line-style*
set lwidth *line-width*
set pattern *fill pattern*
sub *sub-name paramter1 paramter2 etc*
tex *string* [name *xxx*] [add *val*]
text *unquoted-text-string*
write *string$* ...

## 3.2 Graphics Primitives (in detail)

! *comment*

Indicates the start of a comment. GLE ignores everything from the exclamation point to the end of the line. This works both in GLE scripts and in data files used in, e.g., graph blocks.

@*xxx*

Executes subroutine *xxx*.

aline *x y* [arrow start] [arrow end] [arrow both] [curve $\alpha 1$ $\alpha 2$ *d1 d2*]

Draws a line from the current point to the absolute coordinates *(x,y)*, which then becomes the new current point. The arrow qualifiers are optional, they draw arrows at the start or end of the line, the size of the arrow is proportional to the current font height.

If the curve option is given, then a Bezier curve is drawn instead of a line. The first control point is located at a distance $d1$ and angle $\alpha 1$ from the current point and the second control point is located at distance $d2$ and angle $\alpha 2$ from *(x,y)*.

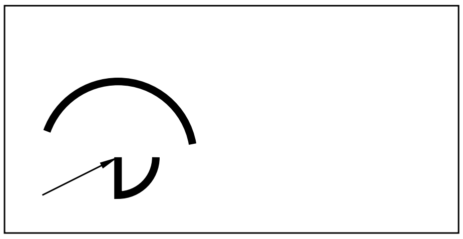
amove *x y*
: Changes the current point to the absolute coordinates *(x,y)*.

arc *radius a1 a2 [arrow end] [arrow start] [arrow both]*
: Draws an arc of a circle in the anti-clockwise direction, centered at the current point, of radius *radius*, starting at angle *a1* and finishing at angle *a2*. Angles are specified in degrees. Zero degrees is at three o'clock and Ninety degrees is at twelve o'clock.

```
    arc 1.2 20 45
```

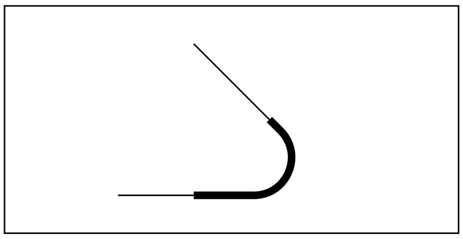
The command narc is identical but draws the arc in the clockwise direction. This is important when constructing a path.

```
amove .5 .5
rline 1 .5 arrow end
arc 1 10 160
arc .5 -90  0
```



arcto *x1 y1 x2 y2 rad*
: Draws a line from the current point to *(x1,y1)* then to *(x2,y2)* but fits an arc of radius *rad* joining the two vectors instead of a vertex at the point *(x1,y1)*.

```
amove 1.5 .5
rline 1 0
set lwidth .1
arcto 2 0 -1 1 .5
set lwidth 0
rline -1 1
```



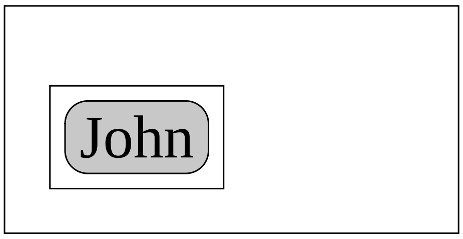
begin *block_name ... end block_name*
: There are several block structured commands in GLE. Each begin must have a matching end. Blocks which change the current graphics state (e.g. scale, rotate, clip etc) will restore whatever they change at the end of the block. Indentation is optional but should be used to make the GLE program easier to read.

begin box [fill *pattern*] [add *gap*] [nobox] [name *xyz*] [round *val*]
: Draws a box around everything between begin box and end box. The option add adds a margin of margin cm to each side of the box to make the box slightly larger than the area defined by the graphics primitives in the begin box . . . end box group (to leave a gap around text for example). The option nobox stops the box outline from being drawn.

The name option saves the coordinates of the box for later use with among others the join command.

If the round option is used, a box with rounded corners will be drawn.

```
begin box add 0.2
   begin box fill gray10 add 0.2 round .3
      text John
   end box
end box
```



begin clip
: This saves the current clipping region. A clipping region is an arbitrary path made from lines and curves which defines the area on which drawing can occur. This is used to undo the effect of a clipping region defined with the begin path command. See the example CLIP.GLE in appendix B at the end of the manual.

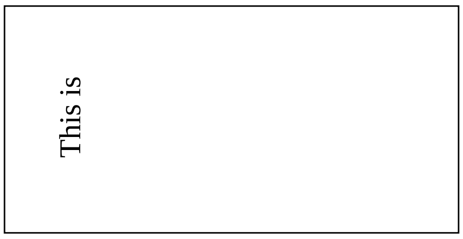
begin name
: Saves the coordinates of what is inside the block for later use with among others the join command. This command is equivalent to 'begin box name . . . nobox'.

begin origin
: This makes the current point the origin. This is good for subroutines or something which has been drawn using amove,aline. Everything between the begin origin and end origin can be moved as one unit. The current point is also saved and restored.

begin path [stroke] [fill *pattern*] [clip]
: Initialises the drawing of a filled shape. All the lines and curves generated until the next end path command will be stored and then used to draw the shape. stroke draws the outline of the shape, fill paints the inside of the shape in the given colour and clip defines the shape as a clipping region for all future drawing. Clipping and filling will only work on PostScript devices.

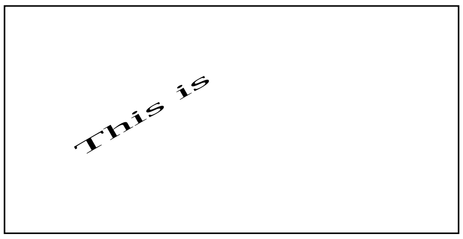
begin rotate *angle*
: The coordinate system is rotated anti-clockwise about the current point by the angle *angle* (in degrees). For example, to draw a line of text running vertically up the page (as a Y axis label, say), type:

```
begin rotate 90
   text This is
end rotate
```



begin scale *x y*
: Everything between the begin and end is scaled by the factors x and y. E.g., *scale 2 3* would make the picture twice as wide and three times higher.

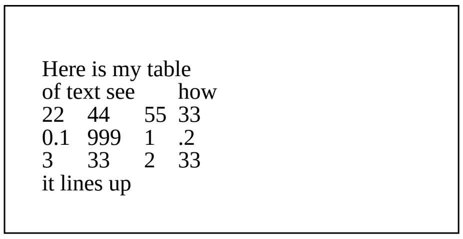
```
begin scale 3 1
   begin rotate 30
      text This is
   end rotate
end scale
```



begin table
: This module is an alternative to the TEXT module. It reads the spaces and tabs in the source file and aligns the words accordingly. A single space between two words is treated as a real space, not an alignment space.

With a proportionally spaced font columns will line up on the left hand side but not on the right hand side. However with a fixed pitch font, like tt, everything will line up.

```
begin table
   Here is my table
   of text see  how
     22   44    55  33
     0.1  999   1   .2
     3    33    2   33
   it lines up
end table
```



```
Here is my table
of text see      how
22   44    55  33
0.1  999   1   .2
3    33    2   33
it lines up
```

begin text [width *exp*]
: This module displays multiple lines/paragraphs of text. The block of text is justified according to the current justify setting. See the set just command for a description of justification settings.

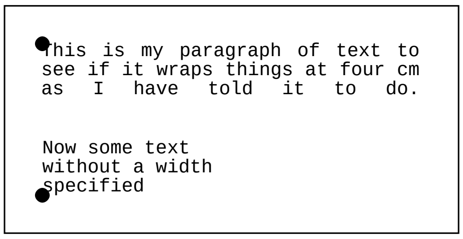
If a width is specified the text is wrapped and justified to the given width. If a width is not given, each line of text is drawn as it appears in the file. Remember that GLE treats text in the same way that LaTeX does, so multiple spaces are ignored and some characters have special meaning. E.g, `\ ^ _ & { }`

To include Greek characters in the middle of text use a backslash followed by the name of the character. E.g., `3.3\Omega S` would produce "3.3ΩS".

To put a space between the Omega and the S add a backslash space at the end. E.g., `3.3\Omega\ S` produces “3.3Ω S”

Sometimes the space control characters (e.g. `\:`) are also ignored, this may happen at the beginning of a line of text. In this case use the control sequence `\glass` which will trick GLE into thinking it isn’t at the beginning of a line. E.g.,

```
     text \glass \:\: Indented text
set hei 0.25 just tl font tt
begin text width 5
   This is my paragraph of text to see
   if it wraps things at four cm as I have
   told it to do.
end text
...
begin text
   Now some text without
   a width
   specified
end text
```


This is my paragraph of text to see if it wraps things at four cm as I have told it to do.

Now some text without a width specified

There are several LaTeX like commands which can be used within text. The complete list can be found in Appendix A.3. A few examples are:

| | |
|---|---|
| `\ \' \v \u \= \^ \. \H \~ \''` | Implemented TeX accents |
| `^{} _{}` | Superscript, subscript |
| `\\ \_` | Forced Newline, underscore character |
| `\, \: \;` | 0.5em, 1em, 2em space (em = width of the letter ‘m’) |
| `\tex{expression}` | Any LaTeX expression |
| `\char{22}` | Any character in current font |
| `\glass` | Makes move/space work on beginning of line |
| `\rule{2}{4}` | Draws a filled in box, 2cm by 4cm |
| `\setfont{rmb}` | Sets the current text font |
| `\sethei{0.3}` | Sets the font height (in cm) |
| `\setstretch{2}` | Scales the quantity of glue between words |
| `\lineskip{0.1}` | Sets the default distance between lines of text |
| `\linegap{-1}` | Sets the minimum required gap between lines |
| `{\rm ...}, {\it ...}` | Sets roman, and italic font |
| `{\bf ...}, {\tt ...}` | Sets bold, and typewriter (monospaced) font |
| `\alpha, \beta, ...` | Greek symbols |

begin translate *x y*

Everything between the begin and end is moved x units to the right and y units up.

bezier *x1 y1 x2 y2 x3 y3*

Draws a Bézier cubic section from the current point to the point *(x3,y3)* with Bézier cubic control points at the coordinates *(x1,y1)* and *(x2,y2)*. For a full explanation of Bézier curves see the PostScript Language Reference Manual.

bitmap *filename width height* [type *type*]

Imports the bitmap *filename*. The bitmap is scaled to *width*×*height*. If one of these is zero, it is computed based on the other one and the aspect ratio of the bitmap. GLE supports TIFF, JPEG, PNG and GIF bitmaps (depending on the compilation options).

Bitmaps are compressed automatically by GLE using either the LZW or the JPEG compression scheme.

bitmap_info *filename width height* [type *type*]

Returns the dimensions in pixels of the bitmap in the output parameters *width* and *height*.

box *x y* [justify *jtype*] [fill *color*] [name *xxx*] [nobox] [round *val*]

Draws a box, of width *x* and height *y*, with its bottom left corner at the current point. If the justify option is used, the box will be positioned relative to the specified point. E.g., TL = top left, CC = center center, BL = bottom left, CENTER = bottom center, RIGHT = bottom right, LEFT = bottom left. See set just for a description of justification settings.

If a fill pattern is specified, the box will be filled. Remember that white fill is different from no fill pattern - white fill will erase anything that was inside the box.

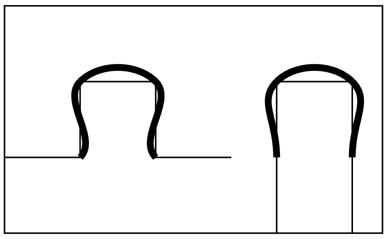
If the round option is used, a box with rounded corners will be drawn.

circle *radius* [fill *pattern*]
: Draws a circle at the current point, with radius *radius*. If a fill pattern is specified the circle will be filled.

closepath
: Joins the beginning of a line to the end of a line. I.e., it does an aline to the end of the last amove.

curve *ix iy* [*x1 y1 x y x y ... xn yn*]*ex ey*
: Draws a curve starting at the current point and passing through the points *(x1,y1)* ... *(xn,yn)*, with an initial slope of *(ix,iy)* to *(x1,y1)* and a final slope of *(ex,ey)*. All the vectors are relative movements from the vector before.

```
amove 1 1
curve 1 0 0 1 1 0 0 -1 1 0
amove 3.6 1
curve 0 1 0 1 1 0 0 -1 0 -1
```



margins *top bottom left right*
: This command can be used to define the page margins. Margins are only relevant for making full-page figures (using the -fullpage command line option). See also the “papersize command.

define marker *markername subroutine-name*
: This defines a new marker called *markername* which will call the subroutine *subroutine-name* whenever it is used. It passes two parameters, the first is the requested size of the marker and the second is a value from a secondary dataset which can be used to vary size or rotation of a marker for each point plotted.

To define a character from the postscript ZapDingbats font as a marker you would use, e.g.

```
sub subnamex size mdata
   gsave                              ! save font and x,y
   set just left font pszd hei size
   t$ = "\char{102}"
   rmove -twidth(t$)/2 -theight(t$)/2  ! centers marker
   write t$
   grestore                           ! restores font and x,y
end sub
```

The second parameter can be supplied using the *mdata* command when drawing a graph, this gives the marker subroutine a value from another dataset to use to draw the marker. For example the marker could vary in size, or angle, with every one plotted.

```
d3 marker myname mdata d4
```

define *markername fontname scale dx dy*
: This command defines a new marker, from any font, it is automatically centered but can be adjusted using dx,dy. e.g.

```
defmarker hand pszd 43 1 0 0
```

ellipse *dx dy [options]*
: This command draws an ellipse with the diameters *dx* and *dy* in the *x* and *y* directions, respectively. The *options* are the same as the circle command.

elliptical_arc *dx dy theta1 theta2 [options]*
: This command is similar to the arc command except that it draws an elliptical arc in the clockwise direction with the diameters *dx* and *dy* in the *x* and *y* directions, respectively. *theta1* and *theta2* are the start and stop angle, respectively. The *options* are the same as for the arc command.

The command elliptical_narc is identical but draws the arc in the clockwise direction. This is important when constructing a path.

for *var* = *exp1* to *exp2* [step *exp3*] *command [...]* next *var*

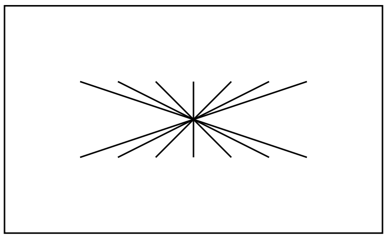
The for ... next structure lets you repeat a block of statements a number of times.

GLE sets var equal to *exp1* and then repeats the following steps.

- If var is greater than *exp2* then GLE commands are skipped until the line after the next statement.
- The value *exp3* is added to var.
- The statements between the for and next statement are executed.

If *exp1* is greater than *exp2* then the loop is not executed.

```
for x = 1 to 4 step 0.5
   amove x 1
   aline 5-x 2
next x
```



grestore

Restores the most recently saved graphics state. This is the simplest way to restore complicated transformations such as rotations and translations. It must be paired with a previous gsave command.

gsave

Saves the current graphics transformation matrix and the current point and the current colour, font etc.

if *expression* then *command [...]* else *command [...]* end if

If *expression* evaluates to true, then execution continues with the statements up to the corresponding else, otherwise the statements following the else and up to the corresponding end if are executed.

```
amove 3 3
if xpos()=3 then
   text We are at x=3
else
   text We are elsewhere
end if
```

Note: end if is not spelt endif.

include *filename*

Includes the GLE script "filename" into the current script. This is useful for including library scripts with subroutines. GLE searches a number of predefined directories for include files. By default, this includes the current directory and the "lib" or "gleinc" subdirectory of the root directory (GLE_TOP) of your GLE installation. The latter includes a number of subroutine files that are distributed with GLE (Table 3.1). Additional include directories can be defined by means of the environment variable GLE_USRLIB.

join *object1.just sep object2.just* [curve $\alpha 1$ $\alpha 2$ *d1 d2*]

Draws a line between two named objects. An object is simply a point or a box which was given a name when it was drawn.

The justify qualifiers are the standard GLE justification abbreviations (e.g., TL=top left, see set just for details)

If *sep* is written as -, a line is drawn between the named objects e.g.

```
join fred.tr - mary.tl
```

Arrow heads can be included at both ends of the line by writing *sep* as <->. Single arrow heads are produced by <- and ->. Note that *sep* must be separated from object1.just and object2.just by white space.

If the justification qualifiers are omitted, a line will be drawn between the centers of the two objects (clipped at the edges of the rectangles which define the objects).

Table 3.1: Include files distributed with GLE.

| | |
|---|---|
| barstyles.gle | Defines additional styles for bar plots. |
| color.gle | Defines functions for working with colors. |
| colors-gle-4.0.12.gle | Redefines all colors defined in GLE 4.0.12 and before. |
| contour.gle | Subroutines for drawing contour plots |
| electronics.gle | Subroutines for drawing electronical cirquits |
| ellipse.gle | Draw text in an ellipse |
| feyn.gle | Subroutines for drawing Feynmann diagrams |
| graphutil.gle | Subroutines for drawing graphs |
| piesub.gle | Pie chart routines |
| polarplot.gle | Polar plotting routines |
| shape.gle | Drawing various shapes |
| simpletree.gle | Draw simple trees |
| stm.gle | Add labels to images |
| ziptext.gle | Draw zipped text |

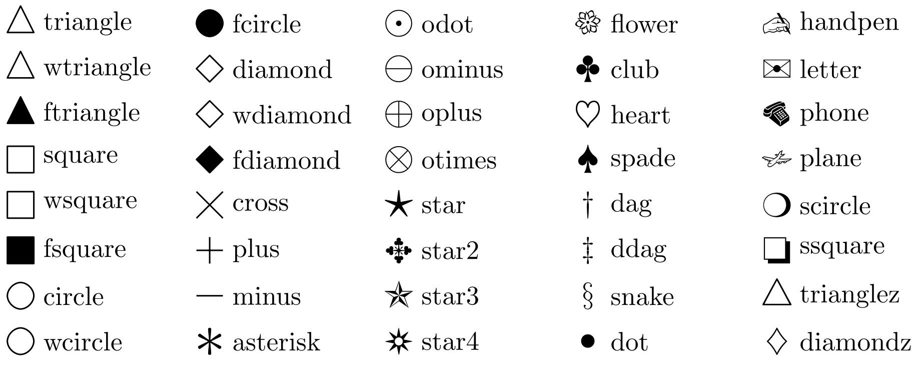


Figure 3.1: All markers supported by GLE. (The names that start with “w” are white filled.)

The curve option is explained with the aline command. Fig. 3.3 shows an example where the “join” command is used with the curve option.

Section 7.1 contains several examples of joining objects.

marker *marker-name* [*scale-factor*]

Draws marker *marker-name* at the current point. The size of the marker is proportional to the current font size, scaled by the value of *scale-factor* if present. Markers are referred to by name, eg. square, diamond, triangle and fcircle. Markers beginning with the letter f are usually filled variants. Markers beginning with w are filled with white so lines are not visible through the marker. For a complete list of markers refer to Fig. 3.1.

```
set just lc
amove 0.5 2.5
marker diamond 1
rmove 0.6 0; text Diamond
amove 0.5 2
marker triangle 1
rmove 0.6 0; text Triangle
...
```

orientation *o*

Sets the orientation of the output in full-page mode. Possible values are “portrait” and “landscape”. Fig. 3.2 illustrates these two cases.

papersize *size*

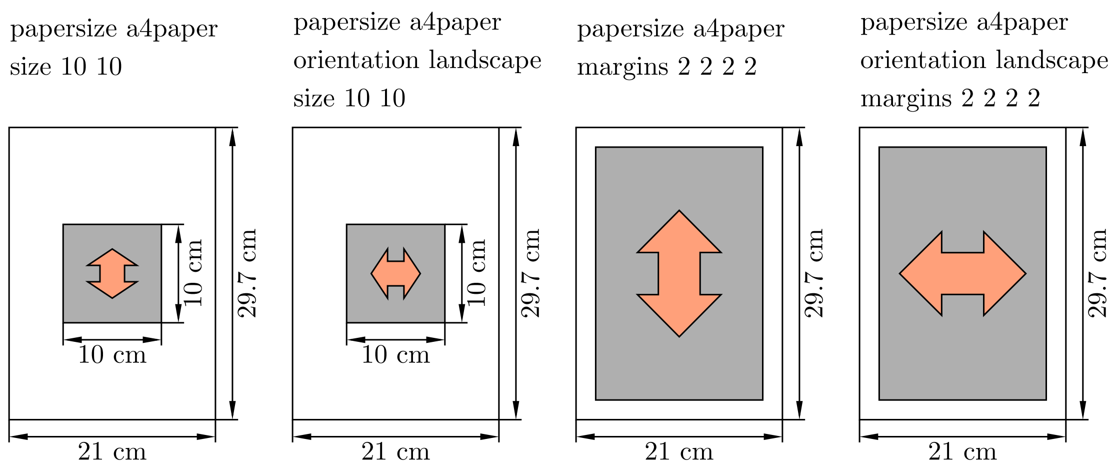


Figure 3.2: Result of different combinations of the commands "papersize", "margins", "size", and "orientation" for fullpage graphics (gle -fullpage figure.gle).

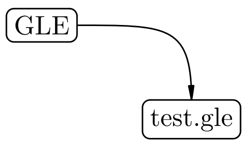


Figure 3.3: Joining two objects using the curve option: "join b1.rc − > b2.tc curve 0 90 1.2 1".

papersize *width height*

Sets the paper size of the output. This is used only when GLE is run with the option "-fullpage". The command either takes one argument, which should be one of the predefined paper size names or two numbers, which give the width and height of the output measured in cm. The following paper sizes are known by GLE: a0paper, a1paper, a2paper, a3paper, a4paper, and letterpaper.

If a "size" command is given in the script, then the output is drawn centered on the page. If no size command is included in the script, then the output will appear relative to the bottom-left corner of the page, offset by the page margins (see "margins" command). Fig. 3.2 illustrates these two cases.

The paper size can also be set in GLE's configuration file (Section 7.5).

postscript *filename.eps width-exp height-exp*

Includes an encapsulated postscript file into a GLE picture, the postscript picture will be scaled up or down to fit the width given. On the screen you will just see a rectangle.

Only the *width-exp* is used to scale the picture so that the aspect ratio is maintained. The height is only used to display a rectangle of the right size on the screen.

print *string$* . . .

This command prints its argument to the console (terminal).

psbbtweak

Changes the default behavior of the bounding box. The default behavior is to have the lower corner at (-1,-1), which for some interpreters (i.e., Photoshop) will leave a black line around the bottom and left borders. If this command is specified then the origin of the bounding box will be set to (0,0).

This command must appear before the first size command in the GLE file.

pscomment *exp*

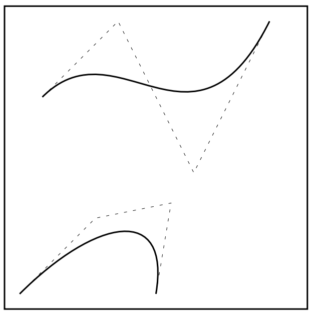
Allows inclusion of *exp* as a comment in the preamble of the postscript file. Multiple pscomment commands are allowed.

This command must appear before the first size command in the GLE file.

rbezier *x1 y1 x2 y2 x3 y3*

This command is identical to the BEZIER command except that the points are all relative to the current point.

```
amove   0.5 2.8
rbezier 1   1   2 -1  3   1
amove   0.2 0.2
rbezier 1   1   2 1.2 1.8 0
```



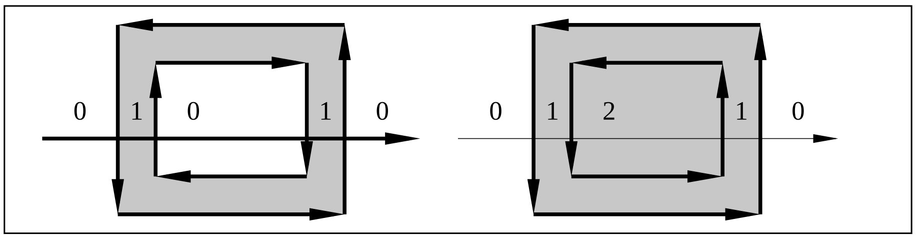
return *exp*

The return command is used inside subroutines to return a value.

reverse

Reverses the direction of the current path. This is used when filling multiple paths in order that the Non-Zero Winding Rule will know which part of the path is 'inside'.

With the Non-Zero Winding Rule an imaginary line is drawn through the object. Every time a line of the object crosses it from left to right, one is added to the counter; every time a line of the object crosses it from right to left, one is subtracted from the counter. Everywhere the counter is non-zero is considered to be the 'inside' of the drawing and is filled.



rline *x y* [arrow end] [arrow start] [arrow both] [curve $\alpha 1$ $\alpha 2$ *d1 d2*]

Draws a line from the current point to the relative coordinates *(x,y)*, which then become the new current point. If the current point is (5,5) then rline 3 -2 is equivalent to aline 8 3. The optional qualifiers on the end of the command will draw arrows at one or both ends of the line, the size of the arrow head is proportional to the current font size.

The curve option is explained with the aline command.

rmove *x y*

Changes the current point to the relative coordinate *(x,y)*. If the current point is (5,5) then rmove 3 -2 is equivalent to amove 8 3.

save *objectname*

This command saves a point for later use with the join command.

set arrowangle angle

Sets the opening angle of the arrow tips. (Actually, half of the opening angle.)

set arrowsize size

Sets the size of the arrow tips.

set cap butt — round — square

Defines what happens at the end of a wide line.

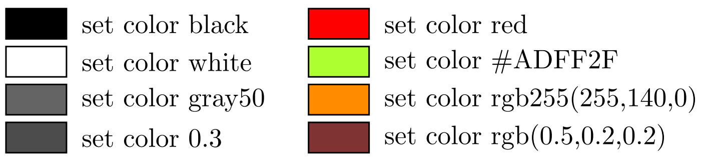


Figure 3.4: Examples of setting the drawing color.

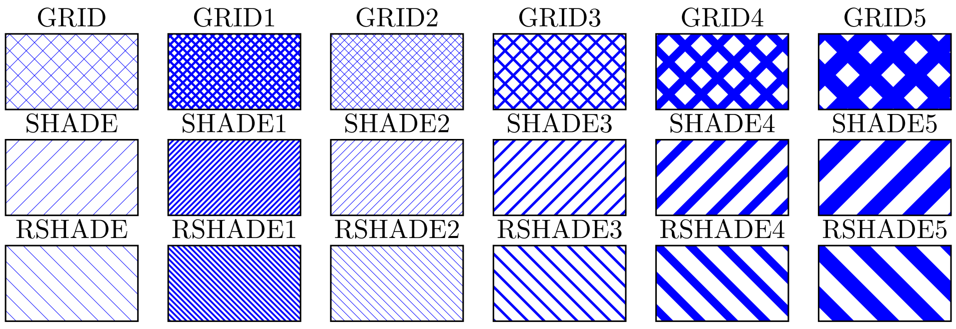
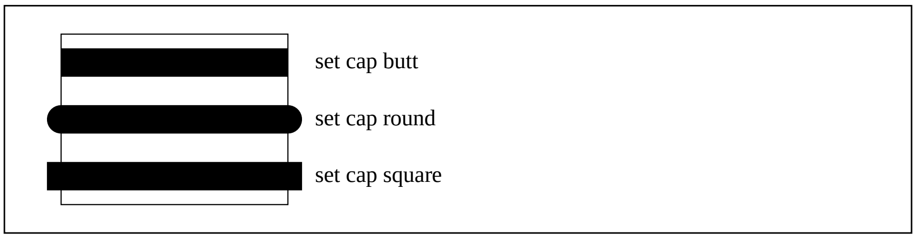


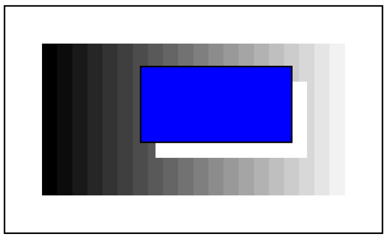
Figure 3.5: Patterns for painting shapes.



set color *col*

Sets the current colour for all future drawing operations. GLE supports all SVG/X11 standard color names. These are listed in Appendix A.7, and include the following: black, white, red, green, blue, cyan, magenta, yellow, gray10, gray20, . . ., gray90. It is also possible to specify a gray scale as a real number with 0.0 = black and 1.0 = white. Colors can also be set using the HTML notation, e.g., #FF0000 = red. Finally, the functions rgb(red,green,blue) and rgb255(red,green,blue) may be used to create custom colors. Fig. 3.4 gives some examples.

```
mm$ = "blue"
amove 0.5 0.5
for c = 0 to 1 step 0.05
   box 0.2 2 fill (c) nobox
   rmove 0.2 0
next c
amove 2 1
box 2 1 fill white nobox
rmove -0.2 0.2
box 2 1 fill mm$
```



set dashlen *dashlen-exp*

Sets the length of the smallest dash used for the line styles. This command MUST come before the set lstyle command. This may be needed when scaling a drawing by a large factor.

set fill *fill color/pattern*

Sets the color or pattern for filling shapes. This command works in combination with shapes such as circles, ellipses, and boxes. If the argument is a color, then shapes are filled with the given color (see “set color). If it is a pattern, then the shapes are painted with the given pattern in black ink. Fig. 3.5 lists a number of pre-defined patterns. To paint a shape in a color different from black, first set the color, then the pattern. That is,

```
set fill red
set pattern shade
box 2 2
```

will draw a box and paint is using the shade pattern and red ink. To draw shapes that are not filled, use the command "set fill clear". That is,

```
set fill clear
box 2 2
```

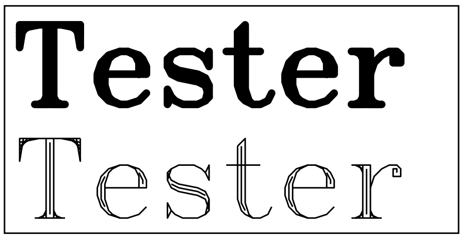
will draw an empty box.

set font *font-name*
Sets the current font to *font-name*. Valid *font-name*s are listed in Appendix A.2.

There are three types of font: PostScript, LaTeX and Plotter. They will all work on any device, however LaTeX fonts are drawn in outline on a plotter, and so may not look very nice. PostScript fonts will be emulated by LaTeX fonts on non-PostScript printers.

set fontlwidth *line-width*
This sets the width of lines to be used to draw the stroked (Plotter fonts) on a PostScript printer. This has a great effect on their appearance.

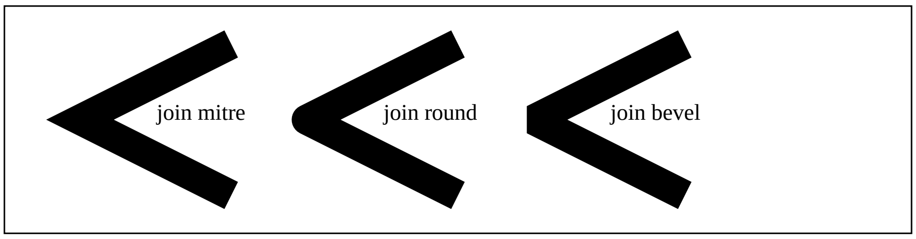
```
set font pltr
amove .2 .2
text Tester
set fontlwidth .1
set cap round
rmove 0 1.5
text Tester
```



set hei *character-size*
Sets the height of text. For historical reasons, concerning lead type and printing conventions, a height of 10cm actually results in capital letters about 6.5cm tall.

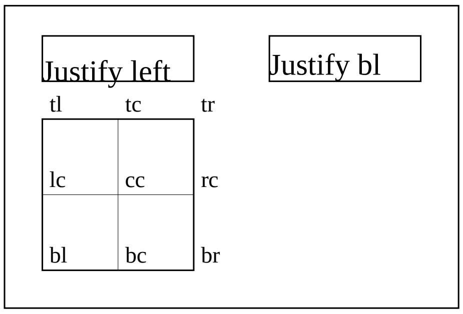
The default value of "hei" is 0.3633 (to mimic the default height of LaTeX expressions).

set join mitre — round — bevel
Defines how two wide lines will be joined together. With mitre, the outside edges of the join are extended to a point and then chopped off at a certain distance from the intersection of the two lines. With **round**, a curve is drawn between the outside edges.



set just left — center — right — tl — etc...
Sets the justification which will be used for text commands.

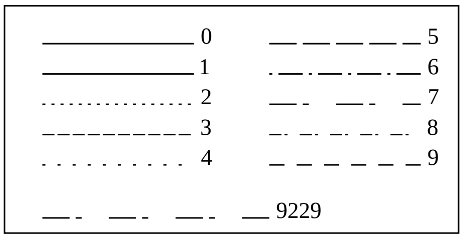
```
amove 0.5 3
set just left
box 1.5 0.6
text Justify left
rmove 2 0
set just bl
box 1.5 0.6
text Justify bl
```



set lstyle *line-style*

Sets the current line style to line style number line-style. There are 9 predefined line styles (1–9). When a line style is given with more than one digit the first digit is read as a run length in black, the second a run length in white, the third a run length in black, etc.

```
set just left
for z = 0 to 4
   set lstyle z
   rline 2 0
   rmove 0.1 0
   write z
   rmove -2.1 -0.4
next z
```



set lwidth *line-width*

Sets the width of lines to *line-width* cm. A value of zero will result in the device default of about 0.02 cm, so a lwidth of .0001 gives a thinner line than an lwidth of 0.

set pattern *fill pattern*

Specifies the filling pattern. A number of pre-defined patterns is listed in Fig. 3.5. See the description of "set fill" for more information.

sub *sub-name parameter1 parameter2 etc.*

Defines a subroutine. The end of the subroutine is denoted with end sub. Subroutines must be defined before they are used.

Subroutines can be called inside any GLE expression, and can also return values. The parameters of a subroutine become local variables. Subroutines are reentrant.

```
sub tree x y a$
   amove x y
   rline 0 1
   write a$
   return x/y
end sub

tree 2 4 "mytree"           (Normal call to subroutine)
slope = tree(2,4,"mytree")  (Using subroutine in an expression)
```

tex *string* [name *xxx*] [add *val*]

Draw a LaTeX expression at the current point using the current value of 'justify'. See Section 7.2 for more information. Using the name option, the LaTeX expression can be named, just like a box. The size of the virtual named box can be increased with the add option.

text *unquoted-text-string*

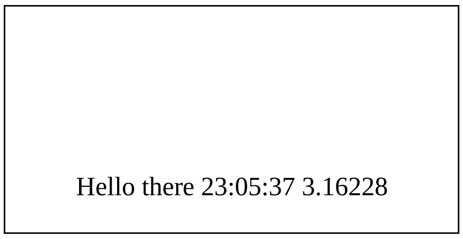
This is the simplest command for drawing text. The current point is unmodified after the text is drawn so following one text command with another will result in the second line of text being drawn on top of the first. To generate multiple lines of text, use the begin text ... end text construct.

```
text "Hi, how's tricks", said Jack!
```

write *string$ ...*

This command is similar to text except that it expects a quoted string, string variable, or string expression as a parameter. If write has more than one parameter, it will concatenate the values of all the parameters.

```
a$ = "Hello there "
xx = sqrt(10)
t$ = time$()
c$ = a$+t$
write a$+t$ xx
```



The built in functions sqrt() and time$() are described in Appendix A.2.

# Chapter 4

# The Graph Module

A graph should start with begin graph and end with end graph. The data to be plotted are organised into datasets. A dataset consists of a series of (X,Y) coordinates, and has a name based on the letter "d" and a number between 1 and 99, eg. d1

The name dn can be used to define a default for all datasets. Many graph commands described below start with d*n*. This would normally be replaced by a specific dataset number e.g.,

```
d3 marker diamond
```

For each xaxis command there is a corresponding yaxis, y2axis and x2axis command for setting the top left and right hand axes. These commands are not explicitly mentioned in the following descriptions.

## 4.1 Graph Commands (a summary)

data *filename* [*d1 d2 d3 ...*] [*d1=c1,c3*] [ignore *n*]
dn bigfile "all.dat,xc,yc" [marker mname] [line]
dn bigfile *xxx$* [autoscale]
dn err *d5* errwidth *width-exp* errup *nn%* errdown *d4*
dn herr *d5* herrwidth *width-exp* herrleft *nn%* errright *d4*
dn key *"Dataset title"*
dn line [impulses] [steps] [fsteps] [hist] [svg_smooth]
dn lstyle *line-style* lwidth *line-width* color *col*
dn marker *marker-name* [msize *marker-size*] [mdata *dn*]
dn nomiss
dn smooth — smoothm
dn xmin *x-low* xmax *x-high* ymin *y-low* ymax *y-high*
fullsize
hscale exp
key pos *tl* nobox hei *exp* offset *xexp yexp*
let ds = *exp* [from *low* to *high* step *exp*]
let dn = [routine] dm [options]
nobox
size *x y*
title *"title"* [hei *ch-hei*] [color *col*] [font *font*] [dist *cm*]
vscale exp
x2labels on
xaxis — yaxis — x2axis — y2axis
xaxis base *exp-cm*
xaxis color *col* font *font-name* hei *exp-cm* lwidth *exp-cm*

xaxis dsubticks *sub-distance*
xaxis format *format-string*
xaxis grid
xaxis log
xaxis min *low* max *high*
xaxis nofirst nolast
xaxis nticks *number* dticks *distance* dsubticks *distance*
xaxis off
xaxis shift *cm-exp*
xlabels font *font-name* hei *char-hei* color *col*
xnames *"name" "name" ...*
xplaces *pos1 pos2 pos3 ...*
xside color *col* lwidth *line-width* off
xsubticks lstyle *num* lwidth *exp* length *exp* off
xticks lstyle *num* lwidth *exp* length *exp* off
xtitle *"title"* [hei *ch-hei*] [color *col*] [font *font*] [dist *cm*]
y2title *"text-string"* [rotate]
yaxis negate
bar *dx,...* dist *spacing*
bar *dx,...* from *dy,...*
bar *dn,...* width *xunits,...* fill *col,...* color *col,...*
fill x1,*d3* color *green* xmin *val* xmax *val*
fill *d4*,x2 color *blue* ymin *val* ymax *val*
fill *d3,d4* color *green* xmin *val* xmax *val*
fill *d4* color *green* xmin *val* xmax *val*

## 4.2 Graph Commands (in detail)

data *filename* [*d1 d2 d3 ...*] [*d1=c1,c3*] [ignore *n*]

Specifies the name of a file to read data from. By default, the data will be read into the next free datasets unless the optional specific dataset names are specified.

A dataset consists of a series of (X,Y) coordinates, and has a name based on the letter d and a number between 1 and 99, e.g. d1 or d4. Up to 99 datasets may be defined.

From a file with 3 columns the command 'data "xx.dat"' would read the first and second columns as the x and y values for dataset 1 (d1) and the first and third columns as the x and y values for dataset 2 (d2). The next data command would use dataset 3 (d3).

A data file for two datasets looks like this:

```
1  2.7   3
2  5     *
3  7.8   7
4  9     4
```

The first coordinate of dataset **d1** would then be (**1,2.7**) and the first coordinate of dataset **d2** would be (**1,3**). The data values can be space, tab or comma separated.

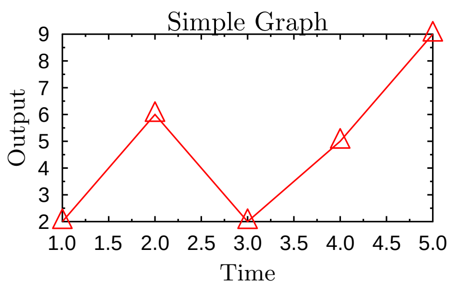
Missing values can be indicated with "*", "?", "-", or ".".

Comments can be included with the symbol "!".

The option d3=c2,c3 allows particular columns of data to be read into a dataset, d3 would read x values from column 2 and y values from column 3.

The option ignore *n* makes GLE ignore the first *n* lines of the data file. This is useful if the first *n* lines contain attribute names/types.

```
size 7 3.5
begin graph
   size   6 3
   title  "Simple Graph"
   xtitle "Time"
   ytitle "Output"
   data   "tut.dat"
   d1 line marker triangle color red
end graph
```



dn bigfile "all.dat,xc,yc" [marker mname] [line]

The bigfile option allows a dataset to be read as it is drawn, (rather than being complete read into memory before it is drawn) this means that very large datasets can be drawn on a PC without running out of memory. The axis minimum and maximum must be specified (using the command xaxis min *exp* max *exp*.

By default the first two columns of the data file will be read in, but other columns may be specified. E.g., all.dat,3,2 would read x values from column 3 and y values from column 2. Or, to read the 4th dataset, specify the file as all.dat,1,5

If the x column is specified as '0' then GLE will generate the x data points. E.g., 1,2,3,4,5...

Bigfile also accepts variables in place of the file name, e.g.

```
xxx$ = "test.dat,2,3"
d1 bigfile xxx$
```

The AUTOSCALE option pre-reads the file to scale the axis, which is slow but sometimes required, e.g.:

```
d1 bifile a.dat line autoscale
```

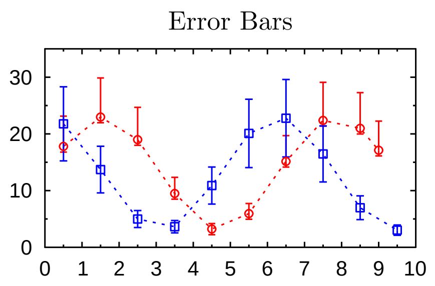
Many (but not all) of the normal dn commands can be used with the bigfile command. E.g., marker, lstyle, xmin, xmax, ymin, ymax, color and lwidth. You cannot use commands like let or bar with the bigfile command.

dn err *d5* errwidth *width-exp* dn errup *nn%* errdown *d4*

For drawing error bars on a graph. The error bars can be specified as an absolute value, as a percentage of the y value, or as a dataset. The up and down error bars can be specified separately e.g.,

```
d3 err .1
d3 err 10%
d3 errup 10% errdown d2
d3 err d1 errwidth .2
```

```
begin graph
   title "Error Bars"
   dn lstyle 2 msize 1.5
   d1 marker circle errup 30% errdown 1
   d2 marker square err   30% errwidth .1
end graph
```



dn herr *d5* herrwidth *width-exp* dn herrleft *nn%* errright *d4*

These commands are identical to the error bar commands above except that they will draw bars in the horizontal plane.

dn key *"Dataset title"*

If a dataset is given a title like this a key will be drawn. Use the key command (below, after hscale) to set the size and position of the key. Use the key module (Chapter 4) to draw more complex keys.

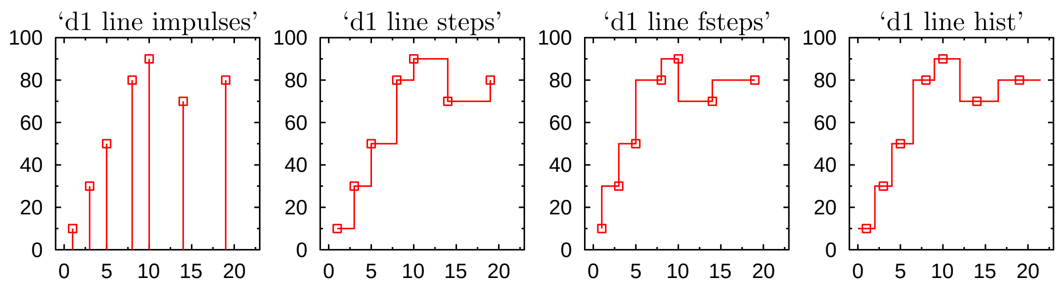


Figure 4.1: The impulses, steps, fsteps, and hist options of the line command.

dn line [impulses] [steps] [fsteps] [hist] [svg_smooth]

This tells GLE to draw lines between the points of the dataset. By default GLE will not draw lines or markers, this is often the reason for a blank graph.

If a dataset has missing values GLE will not draw a line to the next real value, which leaves a gap in the curve. To avoid this behavior simply use the nomiss qualifier on the dn command used to define the line. This simply throws away missing values so that lines are drawn from the last real value to the next real value.

The option svg_smooth performs a Savitski Goulay smoothing on the data.

The options impulses, steps, fsteps, and hist draw lines as shown in Figure 4.1.

- impulses: connects each point with the xaxis.
- steps: connects consecutive points with two line segments: the first from (x1,y1) to (x2,y1) and the second from (x2,y1) to (x2,y2).
- fsteps: connects consecutive points with two line segments: the first from (x1,y1) to (x1,y2) and the second from (x1,y2) to (x2,y2).
- hist: useful for drawing histograms: assumes that each point is the center of a bin of the historgram.

dn lstyle *line-style* lwidth *line-width* color *col*

These qualifiers are all fairly self explanatory. See the lstyle command in Chapter 2 for details of specifying line styles.

dn marker *marker-name* [msize *marker-size*] [mdata *dn*]

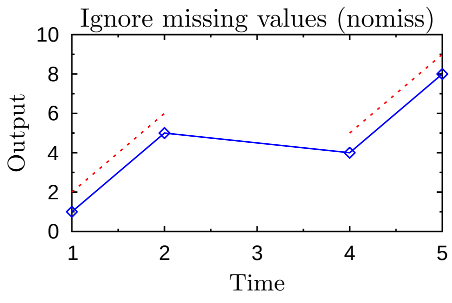
Specifies the marker to be used for the dataset. There is a set of pre-defined markers (refer to Appendix A.1 for a list) which can be specified by name (e.g., circle, square, triangle, diamond, cross, ...). Markers can also be a user-defined subroutine (See the define marker command in Chapter 2). The mdata option allows a secondary dataset to be defined which will be used to pass another parameter to the marker subroutine, this allows each marker to be drawn at a different angle,size or colour.

The msize qualifier sets the marker size for that dataset. The size is a character height in cm, so that the actual size of the markers will be about 0.7 of this value.

dn nomiss

If a dataset has missing values, GLE will not draw a line to the next real value, which leaves a gap in the curve. To avoid this behavior simply use the nomiss qualifier on the dn command used to define the line. This simply ignores missing values.

```
begin graph
   title  "Ignore missing values (nomiss)"
   xtitle "Time"
   ytitle "Output"
   data   "tut.dat"
   d1 lstyle 2
   d2 nomiss lstyle 1 marker diamond msize .2
end graph
```



dn smooth — smoothm

This will make GLE draw a smoothed line through the points. A third degree polynomial is fitted piecewise to the given points.

The smoothm alternative will work for multi valued functions, i.e., functions which have more than one y value for each x value.

dn xmin *x-low* xmax *x-high* ymin *y-low* ymax *y-high*

These commands map the dataset onto the graph's boundaries. The data will be drawn as if the X axis was labelled from *x-low* to *x-high* (regardless of how the axis is actually labelled). A point in the dataset at X = *x-low* will appear on the left hand edge of the graph.

fullsize

This is equivalent to vscale 1, hscale 1, noborder. It makes the graph size command specify the size and position of the axes instead of the size of the outside border.

hscale exp

Scales the length of the yaxis. See vscale. The default value is 0.7.

key pos *tl* nobox hei *exp* offset *xexp yexp*

This command allows the features of a key to be specified. The pos qualifier sets the position of the key. E.g., tl=topleft, br=bottomright, etc.

let ds = *exp* [ from *low* to *high* step *exp*]

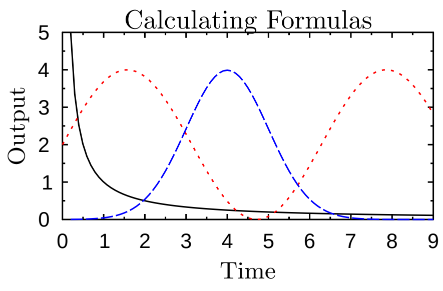
This command defines a new dataset as the result of an expression on the variable x over a range of values. It also allows the use of other datasets. E.g., to generate an average of two datasets:

```
data "file.csv" d1 d2
let d3 = d1+d2/2
```

Or to generate data from scratch:

```
let d1 = sin(x)+log(x) from 1 to 100 step 1
```

```
begin graph
   ...
   let d1 = 1/x from 0.2 to 10
   let d2 = sin(x)*2+2 from 0 to 10
   let d3 = 10*(1/sqrt(2*pi))*
            exp(-2*(sqr(x-4)/sqr(2)))
            from 0.2 to 10 step 0.1
   dn line
   d2 lstyle 2 color red
   d3 lstyle 3 color blue
end graph
```



If the xaxis is a LOG axis then the step option is read as the number of steps to produce rather than the size of each step. The "from", "to", and "step" parameters are optional. The values of "from" and "to" default to the horizontal axis' range.

**NOTE: The spacing around the '=' sign and the lack of spaces inside the expression are necessary.**

let *dn* = [routine] *dm* [options]

GLE includes several fitting routines that allow an equation to be fit to a data series. These routines can be included in a 'let' expression as shown above, where *dn* will contain results of fitting routine to the data in *dm*, and the [options] control the limits to which the data in *dn* extends.

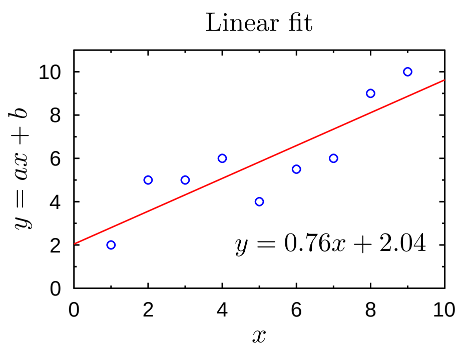
The following routines are available :

- `linfit`: fits the data in *dm* to the straight line equation $y = m \cdot x + b$.
- `logfit`: fits the data in *dm* to the equation $y = a \cdot \exp(b \cdot x)$.
- `log10fit`: fits the data in *dm* to the equation $y = a \cdot 10^{b \cdot x}$.
- `powxfit`: fits the data in *dm* to the equation $y = a \cdot x^b$.

The following options are available :

- `limit_data_x` The range of the data in *dn* extends from the minimum $x$ value in *dm* to the maximum $x$ value in *dm*.
- `limit_data_y` The range of the data in `dn` extends from the $x$ value of the minimum $y$ value in *dm* to the $x$ value of the maximum $y$ value in *dm*.
- `limit_data` The range of the data in *dn* extends from the greater of the $x$ value of the minimum $y$ value or the minimum $x$ value in *dm* to the greater of the $x$ value of the maximum $y$ value or the maximum $x$ value in *dm*.
- `from` *xmin* `to` *xmax* The range of the data in *dn* extends from the *xmin* to *xmax* as specified by the user.

```
slope = 0; offs = 0

begin graph
   title  "Linear fit"
   xtitle "$x$"
   ytitle "$y = ax + b$"
   data   "fitlin.dat"
   let d2 = linfit d1 from 0 to 10 slope offs
   d1 marker circle
   d2 line
end graph

set just rc
amove xg(xgmax)-0.25 yg(2)
tex "$y = " + format$(slope,"fix 2") +
    "x + "  + format$(offs,"fix 2")  + "$"
```



nobox

This removes the outer border from the graph.

size $x$ $y$

Defines the size of the graph in cm. This is the size of the outside box of a graph. The default size of the axes of the graph will be 70% of this, (see vscale and hscale). This command is required.

title *"title"* [hei *ch-hei*] [color *col*] [font *font*] [dist *cm*]

This command gives the graph a centred title. The list of optional keywords specifies features of it. The dist command is used for moving the title up or down.

vscale exp

This sets the width of the axis relative to the width of the graph. For example with a 10cm wide graph and a vscale of .6 the x axis would be 6cm long. A setting of 1.0 makes the xaxis the same length as the width of the graph, which is useful for positioning some graphs. The default value is 0.7.

x2labels on

This command 'activates' the numbering of the x2axis. There is a corresponding command 'y2axis on' which will activate y2axis numbering.

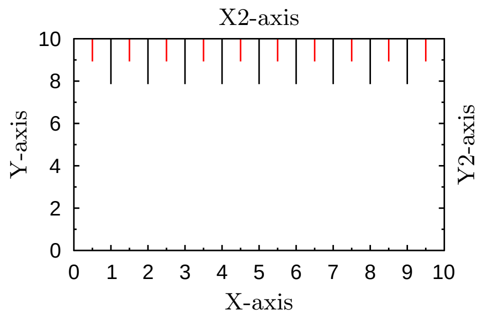
xaxis — yaxis — x2axis — y2axis

A graph is considered to have four axes: The normal xaxis and yaxis as well as the top axis (x2axis) and the right axis (y2axis).

Any command defining an xaxis setting will also define that setting for the x2axis.

The secondary axes x2 and y2 can be modified individually by starting the axis command with the name of that axis. E.g.,

```
begin graph
   size 6 3
   xtitle  "X-axis"
   ytitle  "Y-axis"
   x2title "X2-axis"
   y2title "Y2-axis"
   x2ticks length 0.6
   x2subticks color red
end graph
```



xaxis base *exp-cm*
: Scale the axis font and ticks by *exp-cm*.

xaxis color *col* font *font-name* hei *exp-cm* lwidth *exp-cm*
: These axis qualifiers affect the colour, lstyle, lwidth, and font used for drawing the xaxis (and the x2axis). These can be overriden with more specific commands. E.g., 'xticks color blue' would override the axis colour when drawing the ticks. The subticks would also be blue as they pick up tick settings by default.

xaxis dsubticks *sub-distance*
: See xaxis nticks below.

xaxis format *format-string*
: Specifies the number format for the labels. See the documentation of format$ on page 38 for a description of the syntax. Example:

```
        xaxis format "fix 1"
```

xaxis grid
: This command makes the xaxis ticks long enough to reach the x2axis and the yaxis ticks long enough to reach the y2axis. When used with both the x and y axes this produces a grid over the graph. Use the xticks lstyle command to create a faint grid.

xaxis log
: Draws the axis in logarithmic style, and scales the data logarithmically to match (on the x2axis or y2axis it does not affect the data, only the way the ticks and labelling are drawn)

  Be aware that a straight line should become curved when drawn on a log graph. This will only happen if you have enough points or have used the smooth option.

xaxis min *low* max *high*
: Sets the minimum and maximum values on the xaxis. This will determine both the labelling of the axis and the default mapping of data onto the graph. To change the mapping see the dataset dn commands xmin, ymin, xmax, and ymax.

xaxis nofirst nolast
: These two switches simply remove the first or last (or both) labels from the graph. This is useful when the first labels on the x and y axis are too close to each other.

xaxis nticks *number* dticks *distance* dsubticks *distance*
: nticks specifies the number of ticks along the axis. dticks specifies the distance between ticks and dsubticks specifies the distance between subticks. For example, to get one subtick between every main tick with main ticks 3 units apart, simply specify dsubticks 1.5. Alternatively, one can also use nsubticks.

  By default ticks are drawn on the inside of the graph. To draw them on the outside use the command:

```
     xticks length -.2
     yticks length -.2
```

xaxis off
: Turns the whole axis off — labels, ticks, subticks and line. Often the x2axis and y2axis are not required, they could be turned off with the following commands:

```
     x2axis off
     y2axis off
```

xaxis shift *cm-exp*

This moves the labelling to the left or right, which is useful when the label refers to the data between the two values.

xlabels font *font-name* hei *char-hei* color *col*

This command controls the appearance of the axis labels but not the axis title.

xnames *"name" "name" ...*

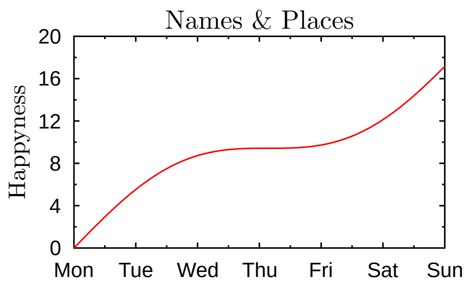
This command replaces the numeric labelling with absolutely anything. Given data consisting of seven measurements, taken from Monday to Sunday, one per day then

```
xnames "Mon" "Tue" "Wed" "Thu" "Fri" "Sat" "Sun"
xaxis min 0 max 6 dticks 1
```

would give the desired result. Note it is essential to define a specific axis minimum, maximum, dticks, etc., otherwise the labels may not correspond to the data.

If there isn't enough room on the line for all the names then simply use an extra xnames command.

```
begin graph
   ytitle "Happyness"
   title  "Names \& Places"
   xnames "Mon" "Tue" "Wed" "Thu"
   xnames "Fri" "Sat" "Sun"
   xaxis  min 0 max 6 dticks 1
   ...
end graph
```



xplaces *pos1 pos2 pos3 ...*

This is similar to the xnames command but it specifies a list of points which should be labelled. This allows labelling which isn't equally spaced. For example:

```
xplaces 1     2     5     7
xnames "Mon" "Tue" "Fri" "Sun"
```

If there isn't enough room on the line for all the places then simply use an extra xplaces command.

xside color *col* lwidth *line-width* off

This command controls the appearance of the axis line, i.e. the line to which the ticks are attached.

xsubticks lstyle *num* lwidth *exp* length *exp* off

This command gives fine control of the appearance of the axis subticks.

xticks lstyle *num* lwidth *exp* length *exp* off

This command gives fine control of the appearance of the axis ticks. Note: To get ticks on the outside of the graph, i.e. pointing outwards, specify a negative tick length:

```
xticks length -.2
yticks length -.2
```

xtitle *"title"* [hei *ch-hei*] [color *col*] [font *font*] [dist *cm*]

This command gives the axis a centered title. The list of optional keywords specify features of it. The dist command is used for moving the title up or down.

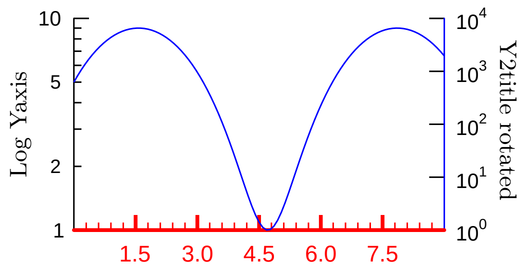
xaxis negate

This is reversed the numbering on the y axis. For use with measurements below ground, where you want zero at the top and positive numbers below the zero.

y2title *"text-string"* [rotate]

By default the y2title is written vertically upwards. The optional rotate keyword changes this direction to downwards. The rotate option is specific to the y2title command.

```
begin graph
   xaxis min 0 max 9 nofirst nolast
   xaxis hei 0.4 nticks 6 dsubticks 0.3
   xaxis lwidth 0.05 color red
   xticks length 0.2
   ytitle "Log Yaxis"
   yaxis log min 1 max 10
   yticks length 0.2
   y2axis min 1 max 10000 format "sci 0 10"
   y2side color blue
   y2title "Y2title rotated " hei 0.3 rotate
   x2axis off
   y2labels on
   let d1 = sin(x)*4+5 from 0 to 9
   dn line color blue
end graph
```



## 4.3 Bar Graphs

Drawing a bar graph is a subcommand of the normal graph module. This allows bar and line graphs to be mixed. The bar command is quite complex as it allows a great deal of flexibility. The same command allows stacked, overlapping and grouped bars.

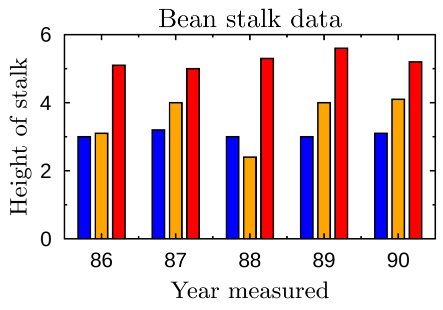
For stacked bars use separate bar commands as in the first example below:

```
bar d1 fill black
bar d2 from d1 fill gray10
```

For grouped bars put all the datasets in a list on a single bar command:

```
bar d1,d2,d3 fill gray10,gray40,black
```

```
begin graph
   title  "Bean stalk data" dist 0.1
   xtitle "Year measured"
   ytitle "Height of stalk"
   xaxis dticks 1
   yaxis min 0 max 6 dticks 2
   data  "gc_bean.dat"
   bar d1,d2,d3 fill blue,orange,red
end graph
```



bar *dx,...* dist *spacing*
: Specifies the distance between bars in dataset(s) dx,.... The distance is measured from the left hand side of one bar to the left hand side of the next bar. A distance of less than the width of a bar results in the bars overlapping.

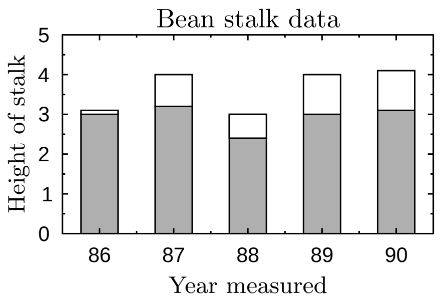
bar *dx,...* from *dy,...*
: This sets the starting point of each bar in datasets dx,... to be at the value in datasets dy,..., and is used for creating stacked bar charts. Each layer of the bar chart is created with an additional bar command.

```
bar d1,d2
bar d3,d4 from d1,d2
bar d5,d6 from d3,d4
```

Note 1: It is important that the values in d3 and d4 are greater than the values in d1 and d2.

Note 2: Data files for stacked bar graphs should not have missing values, replace the * character with the number on its left in the data file.

```
begin graph
   ...
   data "gc_bean.dat"
   bar d1 fill gray20
   bar d2 from d1 fill white
end graph
```



bar *dn,...* width *xunits,...* fill *col,...* color *col,...*

The rest of the bar qualifiers are fairly self explanatory. When several datasets are specified, separate them with commas (with no spaces between commas).

```
bar d1,d2 width 0.2 dist 0.2 fill gray10,gray20 color red,green
```

## 4.4 3D Bar Graphs

3d Bar graphs are now supported, the commands are:

```
bar d1,d2  3d .5 .3  side red,green  notop
bar d3,d4  3d .5 .3  side red,green top black,white
```

Take note of comma's.

bar *dx,...* 3d *xoffset yoffset* side *color list* top *color list* [notop]

3d *xoffset yoffset*

Specifies the x and y vector used to draw the receding lines, they are defined as fractions of the width of the bar. A negative xoffset will draw the 3d bar on the left side of the bar instead of the right hand side.

side *color list*

The color of the side of each of the bars in the group.

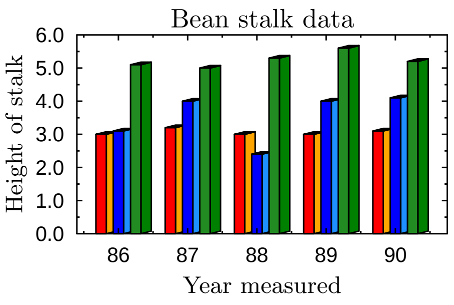
top *color list*

The color of the top part of the bar

notop

Turns off the top part of the bar, use this if you have a stacked bar graph so you only need sides on the lower parts of each stack.

```
begin graph
   ...
   data "gc_bean.dat"
   bar d1,d2,d3 dist 0.25 width 0.15 3d 1 0.25 &
       fill red,blue,forestgreen &
       side orange,dodgerblue,green
end graph
```



Note: You won't see the color of the side or top on the pc screen.

## 4.5 Filling Between Lines

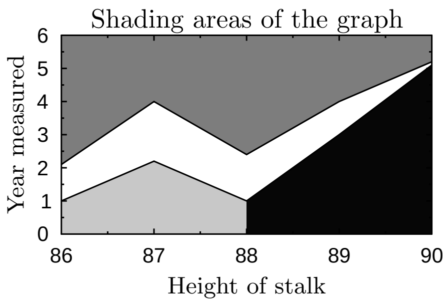
fill x1,*d3* color *green* xmin *val* xmax *val*
: Fills between the xaxis and a dataset, use the optional xmin, xmax, ymin, ymax qualifiers to clip the filling to a smaller region

fill *d4*,x2 color *blue* ymin *val* ymax *val*
: This command fills from a dataset to the x2axis.

fill *d3,d4* color *green* xmin *val* xmax *val*
: This command fills between two datasets.

fill *d4* color *green* xmin *val* xmax *val*
: This command treats the dataset as a polygon and fills it. The dataset should be a closed polygon.

```
begin graph
   title  "Shading areas of the graph" dist 0.1
   xtitle "Height of stalk"
   ytitle "Year measured"
   xaxis min 86 max 90
   yaxis min 0  max 6
   data "gc_fill.dat"
   fill d2,x2 color gray40
   fill x1,d1 color gray10 xmin 85 xmax 88
   fill x1,d1 color gray90 xmin 88 xmax 91
   dn line
end graph
```



## 4.6 Notes on Drawing Graphs

### 4.6.1 Importance of Order

Most of the graph commands can appear in any order, but in some cases order is significant.

As some let commands operate on data which has been read into datasets, the data commands should precede the let commands.

The wildcard dn command should appear before specific d1 commands which it will override.

By default xaxis commands also change the x2axis, and xlabels commands also change x2labels, so to specify different settings for the x and x2 axes, put the x2 settings after the x settings.

```
begin graph
   size 10 10
   data a.dat
   let d2 = d1*3
   dn marker square lstyle 3   ! sets d1 and d2
   d2 marker dot
   xaxis color green
   xticks color blue
   x2axis color black
end graph
```

### 4.6.2 Line Width

When scaling a graph up or down for publication the default line width may need changing. To do this simply specify a set lwidth command before beginning the graph.

```
size 10 10
set lwidth .1
begin graph
   ...
end graph
```

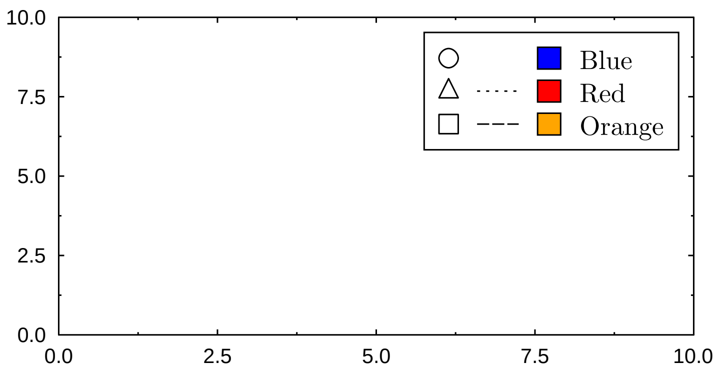
# Chapter 5

# The Key Module

The key module is used for drawing keys. The key can be either specified through a separate key block or directly in the graph block (by prefixing the key commands with the keyword “key”). This chapter first discusses how to define the key using a key block. Section 5.3 shows how to include the key commands directly in a graph block.

The key block usually comes directly after the graph block as follows:

```
begin graph
   ...
end graph

begin key
   position tr
   offset 0.2 0.2
   text "Blue"    marker circle   fill blue
   text "Red"     marker triangle fill red    lstyle 2
   text "Orange"  marker square   fill orange lstyle 3
end key
```



The key block consists of two parts: (a) global commands, and (b) the definitions of the entries. Global commands appear at the beginning of the key and define, e.g., the position of the key. In the example, “position” and “offset” are global commands. Multiple global commands are allowed on a given line. The entry definitions start after the global commands. All comands relevant to a given entry must appear on the same line. In the example, there are three entry definitions and each definition starts with the “text” command. Entries can be organized into columns using the “separator” command.

There are two possible ways to set the position of a key: (a) the key can be positioned relative to the

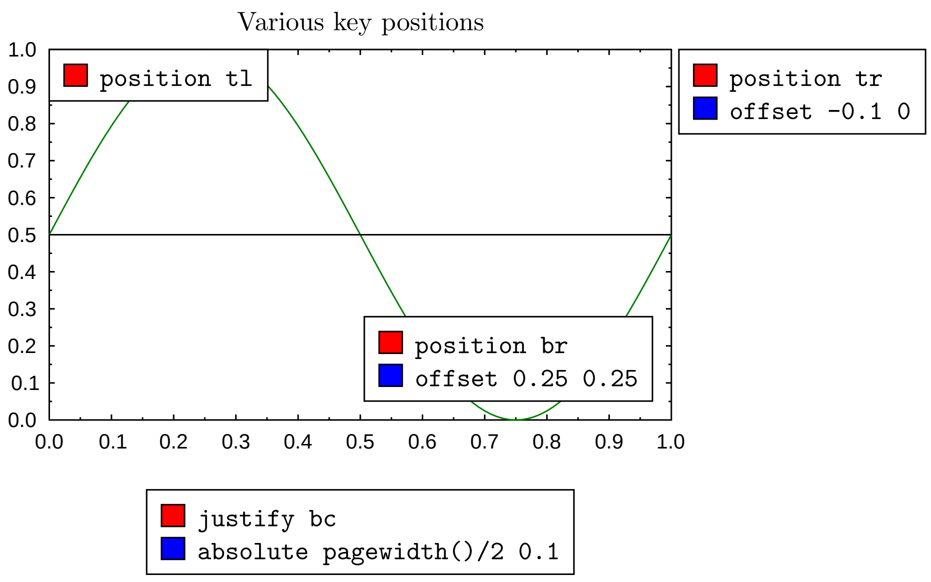


Figure 5.1: Various positions for the key.

graph, and (b) it can be positioned at given coordinates. To position the key relative to the graph, use the commands "position" and (optionally) "offset". For example,

```
position tr
offset 0.2 0.2
```

places the key at the top-right corner of the graph 0.2 cm from each side. To position the key at given coordinates use the "justify" and "absolute" commands. For example,

```
justify bc
absolute 5 0.1
```

places the bottom-center of the key at position (5 cm, 0.1 cm). Fig. 5.1 gives some examples of positioning the key.

## 5.1 Global Commands

Global commands appear at the start of the key block. They control the position of the key and various other properties of the key. Several global key commands may appear on one line in the script.

absolute $x$ $y$
: Places the key at position $(x, y)$ on the figure. The anchor point of the key is specified with the "justify" command.

coldist $d$
: Sets the distance between columns. (To obtain a key with multiple columns, use the "separator" command.)

dist $d$
: Sets the distance between the different components of an entry (the marker, the line, the fill, and the text).

hei $h$
: Sets the height of the text in the entries of the key. If this command is not given, then the current height is used. (To set the current height, use "set hei", see page 18.)

justify *x*
: Sets the anchor point of the key. Possible values: tl, bl, tr, br, tc, bc, lc, rc, cc. These stand for top-left, bottom-left, top-right, bottom-right, top-center, bottom-center, left-center, right-center, and center. Use this command in combination with the “absolute” command. Fig. 5.1 gives some examples.

llen *x*
: Sets the length of the line in the entries.

lpos *x*
: Sets the vertical position of the line in the entries. (This is normally set automatically.)

margins *x y*
: Sets the margins of the key block. (The space between the border and the entries.)

nobox
: Do not draw a border around the key.

offset *x y*
: Specifies the distance in cm between the position specified with the “position” or “pos” command and the actual key. A negative offset places the key outside of the graph (Fig. 5.1).

position *x* or pos *x*
: Specifies the position of the key on the graph. Possible values: tl, bl, tr, br, tc, bc, lc, rc, cc. These stand for top-left, bottom-left, top-right, bottom-right, top-center, bottom-center, left-center, right-center, and center. Optionally, the “offset” command can be combined with this command. Fig. 5.1 gives some examples.

base *h* or row *h*
: Sets the base scale of the entries. The sizes of all components are initialized based on this. E.g., to change the size of the filled box in an entry, use this command.

## 5.2 Entry Definition Commands

Each entry in the key is represented by one line in the key block, and all commands for a given entry must appear on that line. The following commands can be used to define key entries.

color *c*
: Sets the color of the line and marker. The other components of the key are drawn in the default color. (To set the default color, use “set color”, see page 17.)

fill *p*
: Sets the fill color or pattern.

line
: Shorthand for “lstyle 1”.

lstyle *s*
: Sets the line style.

lwidth
: Sets the width of the line.

marker *m*
: Sets the marker.

mscale *x*
: Sets the scale of the marker.

msize *x*
: Sets the size of the marker.

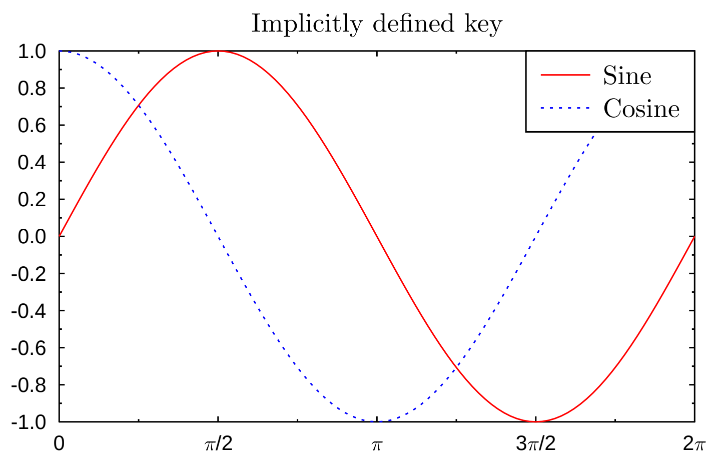


Figure 5.2: Defining the key together with the graph block.

pattern $x$

Sets the filling pattern. Fig. 3.5 shows examples of filling patterns.

separator [lstyle $s$]

Use this command to divide the key into multiple columns. If the "lstyle" option is given, then a line is drawn between the columns in the given style. Possible values are given with the description of the "set lstyle" command on page 19.

text $s$

The text for the entry.

## 5.3 Defining the Key in the Graph Block

It is also possible to define the key in the graph block itself. This is accomplished by prefixing global key commands with the keyword "key". The entries are in this case defined with the "dn" commands and the labels are set with the "key" option to these commands.

The following presents an example:

```
begin graph
   title "Implicitly defined key"
   xaxis min  0 max 2*pi dticks pi/2 format "pi"
   yaxis min -1 max 1
   let d1 = sin(x)
   let d2 = cos(x)
   key pos tr
   d1 line color red           key "Sine"
   d2 line color blue lstyle 2 key "Cosine"
end graph
```

Fig. 5.2 shows the result.

# Chapter 6

# Programming Facilities

## 6.1 Expressions

Wherever GLE is expecting a number it can be replaced with an expression. For example

```
rline 3 2
```

and

```
rline 9/3 sqrt(4)
```

will produce the same result.

An expression in GLE is delimited by white space, so it may not contain any spaces - 'rline 3*3 2' is valid but 'rline 3 * 3 2' will not work.

Or 'let d2 = 3+sin(d1)' will work and 'let d2= 3 + sin(d1)' won't.

Expressions may contain numbers, arithmetic operators (+, -, *, /, ^ (to the power of)), relational operators (>, <, =>, <=, =, <>) boolean operators (and, or), variables and built-in functions.

When GLE is expecting a colour or marker name (like 'green' or 'circle') it can be given a string variable, or an expression enclosed in braces.

## 6.2 Functions Inside Expressions

eval(str)
: Evaluates the given string as if it was a GLE expression and returns the result. E.g., `eval("3+4")` returns 7.

arg(i), arg$(i), nargs()
: Provide access to the command line arguments that are passed to GLE. This is useful for generating multiple similar plots from a single script. arg(i) returns the i-the argument (as a number), arg$(i) returns the i-the argument as a string, and nargs() returns the number of arguments. Only arguments that come after the name of the GLE script are counted. For example, if GLE is run as:

```
gle -o graph-1.eps graph.gle "Title" 0.5
```

then nargs() returns 2, arg$(1) returns "Title", and arg(2) returns 0.5.

The typical use of these functions is to create a script "graph.gle" as follows:

```
size 10 10
begin graph
   title arg$(1)
   data arg$(2)
   d1 line color red
end graph
```

and then creating different graphs by running GLE multiple times:

```
gle -o beans.eps graph.gle "Beans" "beans.csv"
gle -o peas.eps graph.gle "Peas" "peas.csv"
```

This will create two graphs: “beans.eps” and “peas.eps”. The arg() functions can be used at all places in the script where an expression is expected. They can even be used in place of GLE commands in a graph block by means of the \expr() function. For example,

```
data "file.csv"
d\expr{arg(1)} line color red
```

in the graph block will allow one to draw different data sets from a single file on multiple graphs. To do so, run:

```
gle -o d1.eps graph.gle 1
gle -o d2.eps graph.gle 2
```

format$(*exp,format*)
Returns a string representation of *exp* formatted as specified in *format*.

Basic formats:

- dec, hex [upper—lower], bin: format as decimal, hexadecimal (upper-case or lower-case), or binary.
- fix *places*: format with *places* decimal places.
- sci *sig* [e,E,10] [expdigits *num*] [expsign]: format in scientific notation with *sig* significant digits. Use ‘e’, ‘E’, or ‘10’ as notation for the exponent. With the option expdigits the number of digits in the exponent can be set and expsign forces a sign in the exponent.
- round *sig*: format a number with *sig* significant digits.

Options for all formats:

- nozeroes: remove unnecessary zeroes at the end of the number.
- sign: also include a sign for positive numbers.
- pad *nb* [left] [right]: pad the result with spaces from the left or right.
- prefix *nb*: prefix the number with zeroes so that *nb* digits are obtained.
- min *val*: use format for numbers $\geq$ *val*.
- max *val*: use format for numbers $\leq$ *val*.

Examples:

- format$(3.1415, “fix 2”) = 3.14
- format$(3756, “round 2”) = 3800
- format$(3756, “sci 2 10 expdigits 2”) = $3.8 \cdot 10^{03}$

Several formats can be combined into one string: ”sci 2 10 min 1e2 fix 0” uses scientific notations for numbers above $10^2$ and decimal notation for smaller numbers.

pagewidth(), pageheight()
These functions return the width and height of the output. These are the values set with the ‘`size`’ command.

pointx(), pointy()
These functions return the x and y values of a named point.

```
begin box add 0.1 name mybox
    write "Hello"
end box
amove pointx(mybox.bc) pointy(mybox.bc)
rline 0 -2 arrow end
```

twidth(str), theight(str), tdepth(str)
: These functions return the width, depth and height of a string, if it was printed in the current font and size.

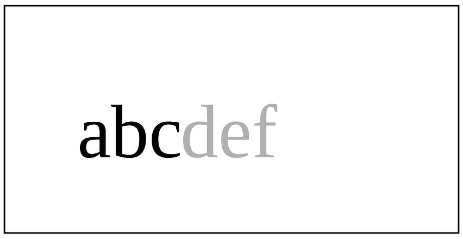
width(obj), height(obj)
: These functions return the width and height of a named object.

xend(), yend()
: These functions return the end point of the last thing drawn. This is of particular interest when drawing text.

```
text abc
set color blue
text def
```

This would draw the def on top of the abc. To draw the def immediately following the abc simply do the following (Note that absolute move is used, not relative move):

```
set just left
text abc
set color gray20
amove xend() yend()
text def
```



xg(), yg()
: With these functions it is possible to move to a position on a graph using the graph's axis units. To draw a filled box on a graph, at position x=948, y=.004 measured on the graph axis:

```
begin graph
   xaxis min 100 max 2000
   yaxis min -.01 max .01
   ...
end graph
amove xg(948) yg(.004)
box 2 2 fill gray10
```

xpos(), ypos()
: Returns the current x and y points.

See Appendix A.2 for an overview of all functions provided by GLE.

## 6.3 Using Variables

GLE has two types of variables, floating point and string. String variables always end with a dollar sign. A string variable contains text like "Hello, this is text", a floating point variable can only store numbers like 1234.234.

```
name$ = "Joe"
height = 6.5   ! Height of person
shoe = 0.05    ! shoe adds to height of person
amove 1 1
box 0.2 height+shoe
write name$
```

## 6.4 Programming Loops

The simple way to draw a 6 × 8 grid would be to use a whole mass of line commands:

```
amove 0 0
rline 0 8
amove 1 0
rline 1 8
...
amove 6 0
rline 6 8
```

this would be laborious to type in, and would become impossible to manage with several grids. By using a simple loop this can be avoided:

```
for x = 0 to 6
   amove x 0
   rline x 8
next x
for y = 0 to 8
   amove 0 y
   rline 6 y
next y
```

To draw lots of grids all of different dimensions a subroutine can be defined and then used again and again:

```
sub grid nx ny
   begin origin
      for x = 0 to nx
         amove x 0
         aline x ny
      next x
      for y = 0 to ny
         amove 0 y
         aline nx y
      next y
   end origin
end sub

amove 2 4
grid  6 8
amove 2 2
grid  9 5
```

Now the main GLE file will be much easier to manage if the subroutine definition is moved into a separate file:

```
include "griddef.gle"

amove 2 4
grid  2 4
amove 2 2
grid  9 5
```

More information about the "include" command can be found on page 13.

### 6.4.1 Default Arguments

Given the following subroutine definition:

```
sub mysub x y color$ fill$
   default color  "black"
   default fill   "clear"
   print "Color: " color$
   print "Fill:  " fill$
end sub
```

the following calls are valid:

```
mysub 1 0
mysub 1 0 red
mysub 1 0 red green
mysub 1 0 fill blue
mysub 1 0 color red
mysub 1 0 color red fill blue
```

## 6.5 I/O Functions

The following I/O functions are available:

fopen *name file* [read|write]
: Open the file "*name*" for reading or for writing. The resulting file handle is stored in variable "*file*" and must be passed to all other I/O functions.

fclose *file*
: Close the given file.

fread *file x1* . . .

freadln *file x1* . . .
: Read entries from "*file*" into given arguments *x1* . . .

fwrite *file x1* . . .
: Write given arguments to "*file*".

fwriteln *file x1* . . .
: Write given arguments to "*file*" and start a new line.

fgetline *file line$*
: Read an entire line from "*file*" and store it in the string "*line$*".

ftokenizer *file commentchar spacetokens singletokens*
: Sets up the parameters of the tokenizer for "*file*".

For example:

```
fopen "file.dat" f1 read
fopen "file.out" f2 write
until feof(f1)
        fread f1 x y z
        aline x y
        rline x z
        fwriteln f2 x*2 "y =" y
next
fclose f1
fclose f2
```

## 6.6 Device dependend Control

A built in function which returns a string describing the device is available.
e.g. `DEVICE$() = "HARDCOPY, PS,"`
on the postscript driver.

This can be used to use particular fonts etc on appropriate devices. E.g.:

```
if pos(device$(),"PS,",1)>0 then
        set font psncsb
end if
```

# Chapter 7

# Advanced features

This chapter covers the advanced features of GLE.

## 7.1 Diagrams, Joining Named Objects

To draw lines between boxes which contain text, first name each box as it is drawn and then use the join command to draw the lines between the boxes.

```
box 2 3 fill blue  name square
amove 5 5
begin box add .1  name titlebox
     text Title
end box
join square.tr -> titlebox.bc
```

These commands draw a line from the “Top Right” of the square to the “Bottom Centre” of the titlebox, with an arrow at the titlebox end.

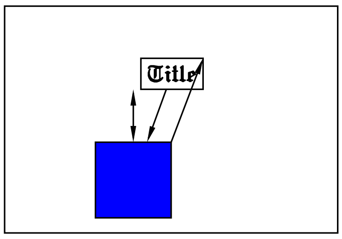
```
join square - titlebox
```

would draw a line from the centre of the square to the centre of the titlebox but clipped correctly at the edges of both boxes.

```
join square.tc <-> titlebox.v
```

would draw a vertical line from the top centre of the square to the titlebox with arrows at both ends.

```
set hei .3 font plge
amove 1.2 .2
box 1 1 fill blue name square
amove 1.9 2
begin box add .1 name titlebox
text Title
end box
join square.tr -> titlebox.tr
join square <- titlebox
join square.tc <-> titlebox.v
```



Named points on each box:

```
.bl Bottom left
.bc Bottom centre
.br Bottom right
.cr Centre right
```

```
.tr Top right
.tc Top centre
.tl Top left
.cl Centre left
.v  Vertical line
.h  Horizontal line
.cc Centre centre
.ci Circle clipping (for drawing lines to a circle)
```

To draw lines to a given point, simply move there and save that point as a named object.

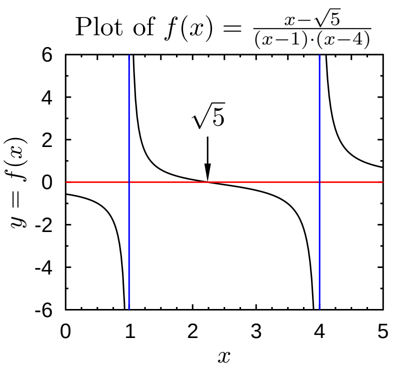
```
rmove 2 3
save apoint
join apoint - square
```

## 7.2 LaTeX Interface

### 7.2.1 Example

GLE files can include arbitrary LaTeX expressions using the LaTeX interface. There are two ways to include a LaTeX expression. The first one is by using the '`tex`' primitive. The second one is by using the '`\tex{}`' macro in a string.

```
begin graph
  ...
  title "\tex{Plot of $f(x) =
        \frac{x-\sqrt{5}}{(x-1)\cdot(x-4)}$}"
  xtitle "\tex{$x$}"
  ytitle "\tex{$y = f(x)$}"
  ...
end graph

set just bc hei 0.6
amove xg(sqrt(5)) yg(2.5)
tex "$\sqrt{5}$" add 0.1 name sq5b

amove pointx(sq5b.bc) pointy(sq5b.bc)
aline xg(sqrt(5)) yg(0) arrow end
```



LaTeX expressions are drawn on top of all other graphics and cannot clipped (Section 7.3).

LaTeX expressions respect the '`just`' setting, but ignore the '`hei`' setting. As a result, the font sizes in your graphics will be exactly the same as in your main document. To obtain different font sizes, use the font size primitives provided by LaTeX (e.g., `\large`, ...). In the future, a setting '`scaletexfonts`' will be added to control scaling of the fonts in LaTeX expression. If this setting is true, GLE will respect the value of '`hei`'.

### 7.2.2 Using LaTeX Packages

If your LaTeX expressions require special LaTeX packages, these can be loaded using the `texpreamble` block. E.g., put the following near the beginning of your GLE file:

```
begin texpreamble
    \documentclass{llncs}
    \usepackage{amsmath}
    \usepackage{amssymb}
    \DeclareMathSymbol{\R}{\mathbin}{AMSb}{"52}
end texpreamble
```

### 7.2.3 Import in a TeX Document

There are two methods for importing the output of a GLE file with TEX expressions in your LATEX document. The most obvious one is by just importing the .eps/.pdf file generated by GLE with `\includegraphics`.

An alternative method is by using GLS's command line option `-inc`. If this option is supplied, then GLE will create besides the usual .eps or .pdf file also an .inc file. This .inc file can be imported in a LATEX document as follows.

```
\input{myfile.inc}
```

The .inc file tells `latex` (or `pdflatex`) to include the .eps/.pdf output file created by GLE. It also includes TEX draw commands for drawing the LATEX expressions on top of the GLE output. Note that the .eps/.pdf file created by GLE does not include these if `-inc` is used (you can check this by viewing it with GhostView).

To be able to include .inc files, the following must be included in the preamble of your LATEX document.

```
\usepackage[dvips]{graphics}
\usepackage{color}
```

If you use `pdflatex`, then the `dvips` option of the graphics package should be replaced by `pdftex`.

If you place your .gle files in a subdirectory of the directory where your LATEX document resides, the .inc file created by GLE should include the path to this subdirectory in the '`\includegraphics`' primitive it uses for including the .eps/.pdf file generated by GLE. To add this path, use the '`-texincprefix`' command line option of GLE. For example, if your GLE files are in a subdirectory called 'plots' then one should run GLE as follows.

```
gle -texincprefix "plots/" -inc myfile.gle
```

GLE can color and rotate LATEX expressions (use '`set color`' and '`begin rotate`'). Note however that '`xdvi`' does not support these effects, so you will not be able to see them if you use this viewer. In the final PostScript or PDF output, they will of course be displayed correctly.

The main advantage of using the `-inc` method is that the resulting file size will be smaller because the LATEX fonts are not included in the .eps/.pdf file generated by GLE.

### 7.2.4 The .gle Directory

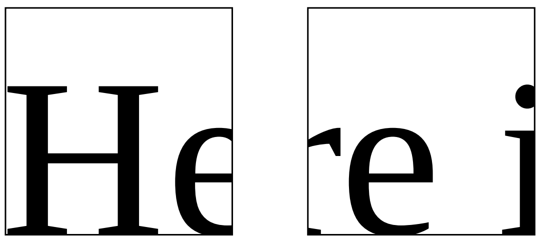
If your source includes LATEX expressions, then GLE will construct a subdirectory called '.gle' for storing temporary files (e.g., used for measuring the printed size of the LATEX expressions). After you are finished you can safely delete the .gle directory. GLE will recreate it automatically if required.

## 7.3 Filling, Stroking and Clipping Paths

It is possible to set up arbitrary clipping regions. To do this draw a shape and make it into a path by putting a `begin path clip ... end path`, around it. Then draw the things to be clipped by that region. To clear a clipping path surround the whole section of GLE commands with `begin clip ... end clip`

Characters can be used to make up clipping paths, but only the PostScript fonts will currently work for this purpose.

```
size 10 5
begin clip       ! Save current clipping path
   begin path clip stroke  ! Define new clipping region
      amove 2 2
      box 3 3
      amove 6 2
      box 3 3
   end path
   amove 2 2
   set hei 3
   text Here is clipped text
end clip         ! Restore original clipping path
```



## 7.4 Colour

Internally GLE treats color and fill identically, they are simply an intensity of red, green and blue. Each of the predefined color names (yellow, grey20, orange, red) simply define the ratio of red, green and blue. A sample of the predefined color names is included in Appendix A.7.

There are two ways to use variables to show color, one is for shades of grey:

```
for i = 0 to 10
   box 3 .2 fill (i/10)
   rmove 0 .2
next i
```

The other is for passing a color **name** as a variable:

```
sub stick c$
   box .2 2 fill c$
end sub
stick "green"
```

A color can also be defined based on its RGB values with the `rgb255` primitive.

```
mycolor$ = "rgb255(38,38,134)"
```

Remember a fill pattern completely obscures what is behind it, so the following command would produce a box with a shadow:

```
amove 4 4
box 3 2 fill grey10
rmove -.1 .1
box 3 2 fill white
rmove .4 .4
text hellow
```

## 7.5 GLE's Configuration File

GLE reads two configuration files during initialization. The first configuration file is the file "glerc" located in the root of your GLE installation. This location is usually referred to as $GLE_TOP. To find out where your $GLE_TOP is, run "`gle -info`". The second configuration file is the file ".glerc" located in your home directory (Unix and Mac OS/X only). The commands in this second file override the commands in $GLE_TOP/glerc.

The configuration files can be used to set various options, such as the paper size and margins.

To set the paper size and margins, add the following block to the configuration file.

```
begin config paper
     size = letterpaper
     margins = 2.54 2.54 2.54 2.54
end config
```

The supported paper sizes are listed with the description of the "`papersize`" command on page 14.

The configuration file can also be used to override default locations of external tools such as GhostScript and LaTeX.

```
begin config tools
     ghostscript = /home/john/apps/gs/bin/gs
end config
```

# Chapter 8

# Surface and Contour Plots

## 8.1 Surface Primitives

### 8.1.1 Overview

Surface plots three dimensional data using a wire frame with hidden line removal.

The simplist surface code would look like this.

```
begin surface
   data "myfile.z" 5 5
end surface
```

The surface block can contain the following commands:
size $x$ $y$
cube [off] [xlen $v$ ] [ylen $v$ ] [zlen $v$ ] [nofront] [lstyle $l$ ] [color $c$ ]
data *myfile.z* [xsample *n1* ] [ysample *n2* ] [sample *n3* ] [nx *n1* ] [ny *n2* ]
harray $n$
xlines — ylines [off]
xaxis — yaxis — zaxis [min $v$ ] [max $v$ ] [step $v$ ] [color $c$ ] [lstyle $l$ ] [hei $v$ ] [off]
xtitle — ytitle — ztitle "title" [dist $v$ ] [color $c$ ] [hei $v$ ]
title "*main title*" [dist $v$ ] [color $c$ ] [hei $v$ ]
rotate $\theta$ $\phi$ x
view x y p
top — underneath [off] [lstyle $n$ ] [color $c$ ]
back [zstep $v$ ] [ystep $v$ ] [lstyle $l$ ] [color $c$ ] [nohidden]
base [xstep $v$ ] [ystep $v$ ] [lstyle $l$ ] [color $c$ ] [nohidden]
right [zstep $v$ ] [xstep $v$ ] [lstyle $l$ ] [color $c$ ] [nohidden]
skirt on
points *myfile.dat*
marker *circle* [hei $v$ ] [color $c$ ]
droplines — riselines [color $c$ ] [lstyle $n$ ]
zclip [min *v1* ] [max *v2* ]

### 8.1.2 Surface Commands

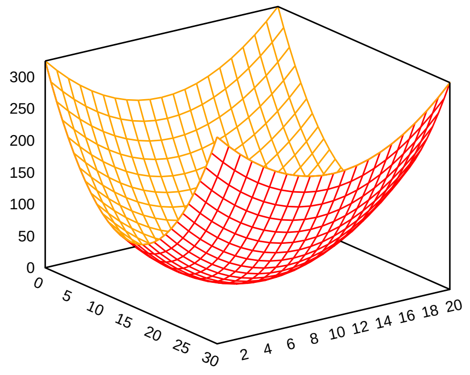
size $x$ $y$

Specifies the size in cm to draw the surface. The 3d cube will fit inside this box. The default is 18cm x 18cm e.g. `size 10 10` cube [off] [xlen *v* ] [ylen *v* ] [zlen *v* ] [nofront] [lstyle *l* ] [COLOR *c* ]

Surface is drawing a 3d cube.

| | |
|---|---|
| off | Stops GLE from drawing the cube. |
| xlen | The length of the cubes x dimension in cm. |
| nofront | Removes the front three lines of the cube. |
| lstyle | Sets the line style to use drawing the cube. |
| color | Sets the color of lines to use drawing the cube. |

```
begin surface
   size 7 7
   data "jack.z"
   cube zlen 13
   top color orange
   underneath color red
end surface
```



data it myfile.z [xsample *n1* ] [ysample *n2* ] [sample *n3* ] [nx *n1* ] [ny *n2* ]

Loads a file of Z values in. The NX and NY dimensions are optional, normally the dimensions of the data will be defined on the first line of the data file. e.g.

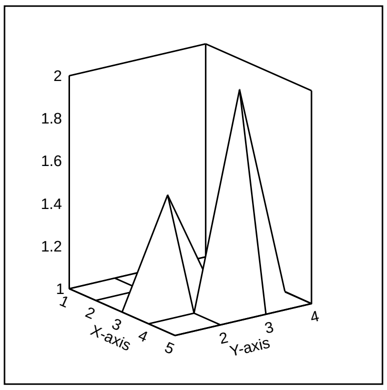
```
! nx 10  ny 20    xmin 1 xmax 10 ymin 1 ymax 20
1 2 42 4 5 2 31 4 3 2 4
1 2 42 4 5 2 31 4 3 2 4 etc...

y1,x1, y1,x2 ... y1,xn
y2,x1, y2,x2 ... y2,xn
        .
.
.
yn,x1, yn,x2 ... yn,xn
```

Data files can be created using LETZ or FITZ. LETZ will create a data file from an x,y function. FITZ will create a data file from a list of x,y,z data points.

| | |
|---|---|
| xsample | Tells surface to only read every n'th data point from the data file. This speeds things up while you are messing around. |
| ysample | Tells surface to only read every n'th line from the data file. |
| sample | Sets both xsample and ysample |

(see also POINTS)

```
begin surface
   size 5 5
   xtitle "X-axis"
   ytitle "Y-axis"
   data   "surf1.z"
end surface
```



harray *n*

The hidden line removal is accomplished with the help of an array of heights which record the current horizon, the quality of the output is proportional to the width of this array. (also the speed of output)

To get good quality you may want to increase this from the default of about 900 to 2 or 3 thousand. e.g. `harray 2000`

xlines off

Stops SURF from drawing lines of constant X.

ylines off

Stops SURF from drawing lines of constant Y.

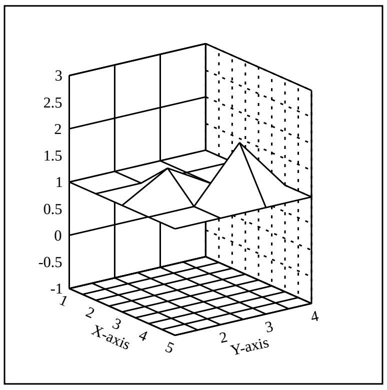
xaxis [min *v* ] [max *v* ] [step *v* ] [color *c* ] [lstyle *l* ] [hei *v* ] [off]

zaxis [min *v* ] [max *v* ] [step *v* ] [color *c* ] [lstyle *l* ] [hei *v* ] [off]

yaxis [min *v* ] [max *v* ] [step *v* ] [color *c* ] [lstyle *l* ] [hei *v* ] [off]

| | |
|---|---|
| min,max | Set the range used for labelling the axis. |
| step | The distance between labels on the axis. |
| color | The color of the axis ticks and labels. |
| lstyle | The line style used for drawing the ticks. |
| ticklen | The length of the ticks. |
| hei | The height of text used for labelling. |
| off | Stops GLE from drawing the axis. |

```
begin surface
   size 5 5
   data "surf1.z"
   zaxis min -1 max 3
   base xstep 0.5 ystep 0.5
   back ystep 1 zstep 1
   right xstep 0.5 zstep 0.5 lstyle 2
   xtitle "X-axis" hei 0.3
   ytitle "Y-axis" hei 0.3
end surface
```



xtitle "x title" [dist *v* ] [color *c* ] [hei *v* ]

ytitle "y title" [dist *v* ] [color *c* ] [hei *v* ]

ztitle "z title" [dist *v* ] [color *c* ] [hei *v* ]

| | |
|---|---|
| dist | Moves the title further away from the axis. |
| color | Sets the color of the title. |
| hei | Sets the hei in cm of the text used for the title. |

title "*main title*" [dist *v* ] [color *c* ] [hei *v* ]

| | |
|---|---|
| dist | Moves the title further away from the axis. |
| color | Sets the color of the title. |
| hei | Sets the hei in cm of the text used for the title. |

rotate $\theta$ $\phi$ x `rotate 10 20 3`

Imagine the unit cube is sitting on the front of your terminal screen, x along the bottom, y up the left hand side, and z coming towards you.

The first number (10) rotates the cube along the xaxis, ie hold the right hand side of the cube and rotate your hand clockwise 10 degrees.

The second number (20) rotates the cube along the yaxis, ie hold the top of the cube and rotate it 20 degrees clockwise.

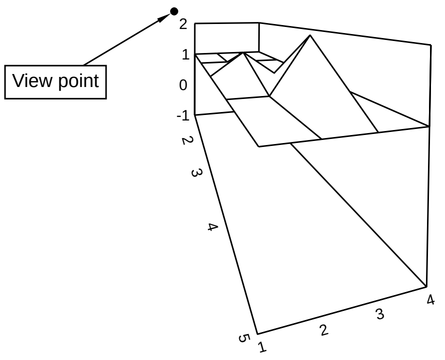
The third number is currently ignored.

The default setting is 60 50 0.

view x y p
: Sets the perspective, this is where the cube gets smaller as the lines dissappear towards infinity.

x and y are the position of infinity on your screen. p is the degree of perspective, 0 = no perspective and with 1 the back edge of the box will be touching infinitiy. Good values are between 0 and 0.6

```
begin surface
   size 5 5
   data "surf1.z"
   zaxis min -1
   rotate 85 85 0
   view 0 5 0.7
end surface
```



top [off] [lstyle *n* ] [color *c* ]
: Sets the features of the top of the surface. By default the top is on.

(see also UNDERNEATH, XLINES, YLINES)

underneath [off] [lstyle *n* ] [color *c* ]
: Sets the features of the under side of the surface. By default the underneath is off.

(see also TOP, XLINES, YLINES)

back [zstep *v* ] [ystep *v* ] [lstyle *l* ] [color *c* ] [nohidden]
: Draws a grid on the back face of the cube.

By default hidden lines are removed but NOHIDDEN will stop this from happenning.

base [xstep *v* ] [ystep *v* ] [lstyle *l* ] [color *c* ] [nohidden]
: Draws a grid on the base of the cube.

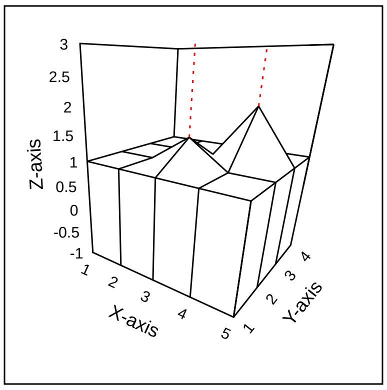
By default hidden lines are removed but NOHIDDEN will stop this from happenning.

right [zstep *v* ] [xstep *v* ] [lstyle *l* ] [color *c* ] [nohidden]
: Draws a grid on the right face of the cube.

By default hidden lines are removed but NOHIDDEN will stop this from happenning.

skirt on
: Draws a skirt from the edge of the surface to ZMIN.

```
begin surface
   size 5 5
   data "surf1.z"
   zaxis min -1 max 3
   xtitle "X-axis"
   ytitle "Y-axis"
   ztitle "Z-axis"
   points "surf3.dat"
   riselines lstyle 2
   marker fcircle
   skirt on
   rotate 60 35 0
   view 2.5 3 0.6
end surface
```



points *myfile.dat*
: Reads in a data file which must have 3 columns (x,y,z)

  This is then used for plotting markers and rise and drop lines.

marker *circle* [hei *v* ] [color *c* ]
: Draws markers at the co-ordinates read from the POINTS file.

droplines [color *c* ] [lstyle*n* ]
: Draws lines from the co-ordinates read from the POINTS file down to zmin.

riselines [color *c* ] [lstyle *n* ]
: Draws lines from the co-ordinates read from the POINTS file up to zmax.

zclip [min *v1* ] [max *v2* ]
: ZCLIP goes through the Z array and sets any Z value smaller than MIN to *v1* and sets any value greater than MAX to *v2*.

## 8.2 Letz

LETZ generates a data file of z values given an expression in terms of x and y.

```
begin letz
   data "jack.z"
   z = x+sin(y^2)/pi+10.22
   x from 0 to 30 step 1
   y from 0 to 20 step 1
end letz
```

The file jack.z now contains the required data. The resulting file can be used to generate surface plots with the begin/end surface block discussed in the previous section.

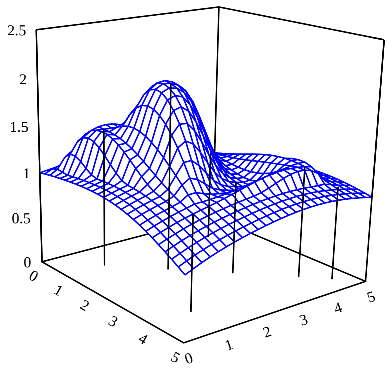
## 8.3 Fitz

FITZ fits smooth curves based on a set of 3D data points. E.g., given some data points (note that each line has three values: an x, y, and z coordinate):

```
x y z
---- data file testf.dat -----
1  1  1
1  2  1
2  2 1
2  1 1
1.5  1.5  2
------------------------------
```

Fitz creates a ".z" file that can be used in a surface block, a colormap or contour plot. The following example illustrates this.

```
begin fitz
   data "fitz.dat"
   x from 0 to 5 step 0.2
   y from 0 to 5 step 0.2
   ncontour 6
end fitz

begin surface
   size 7 7
   data "fitz.z"
   top color blue
   xaxis min 0 max 5 step 1
   yaxis min 0 max 5 step 1
   points "fitz.dat"
   droplines lstyle 1
   marker circle
   view 2.5 3 0.3
   harray 5000
end surface
```

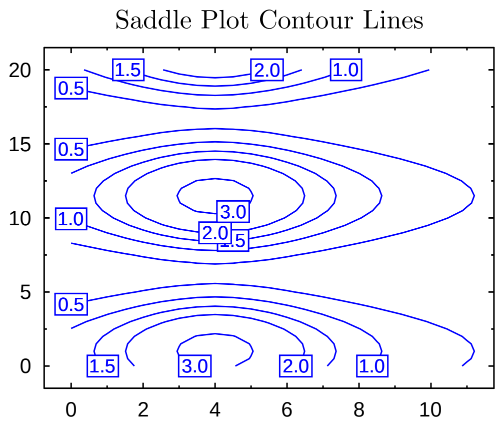


## 8.4 Contour

The contour block produces contour lines of a function $z = f(x, y)$.

The function $f(x, y)$ is given by a .z file. The .z file format is discussed on page 50. Recall that a .z file can be created from sample data points, that is $(x, y, z)$ tuples, with the fitz block (Section 8.3), or from an implicit definition of $f(x, y)$ with a letz block (Section 8.2).

```
include "contour.gle"

begin contour
   data "saddle.z"
   values 0.5 1 1.5 2 3
end contour

begin graph
   title "Saddle Plot Contour Lines"
   data  "saddle-cdata.dat"
   d1 line color blue
end graph

contour_labels "saddle-clabels.dat" "fix 1"
```



The contour block can contain the following commands:

data *file$*
: Specifies the name of the .z file.

values $v_1, \ldots, v_n$
: Specifies the z-values to contour at.

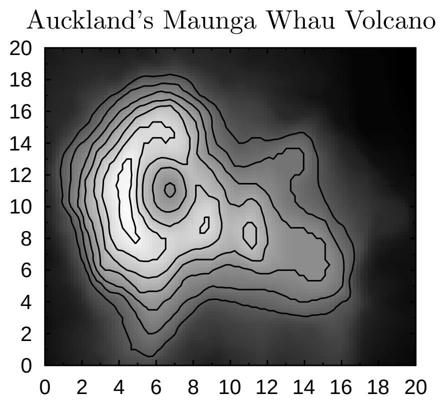
smooth *integer*
: Specifies the smoothing parameter.

The contour block creates the files "data-clabels.dat" and "data-cdata.dat" with the prefix "data" the name of the .z file. The file "data-clabels.dat" contains information for drawing labels on the contour plot. This is done by the subroutine contour_labels defined in the library "contour.gle" in the example above. The file "data-cdata.dat" contains the $(x, y)$ values of the contour lines. This file can be used as input to a graph block and plotted with the "d1 line" command as shown in the example above.

## 8.5 Color Maps

Color maps plot a function $z = f(x, y)$ by mapping $z$ to a color range. The following example combines a color map with a contour plot.

```
begin contour
   data "volcano.z"
   values 130 140 150 160 170 180 190
end contour

begin graph
   title "Auckland's Maunga Whau Volcano"
   data "volcano-cdata.dat"
   xaxis min 0 max 20
   yaxis min 0 max 20
   d1 line color black
   colormap "volcano.z" 100 100
end graph
```



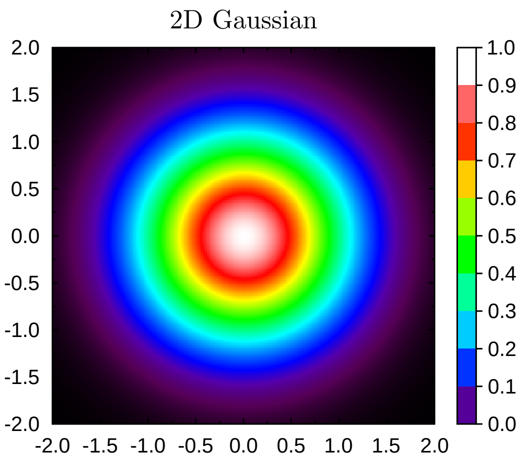
The options to the colormap command are as follows:

colormap *fct pixels-x pixels-y color invert zmin* $z_1$ *zmax* $z_2$ *palette pal*

- *fct* specifies the function to map. This can either be the name of a .z file, or it can be a function definition $f(x, y)$.
- *pixels-x*, *pixels-x* specify the dimension of the color map. A color map is a stored as a bitmap image and (*pixels-x*, *pixels-x*) are the resolution of this bitmap. A larger resolution yields more detail, but at the cost of longer computation time and a larger file size.
- *color* is an optional argument and indicates that the color map should be drawn in color (as opposed to grayscale).
- *invert* is an optional argument that inverts the color map. That is, large function values will be drawn in black and small function values in white.
- *zmin*, *zmax* are optional arguments that specify the range of the function.
- *palette* is an optional argument that specifies the palette to use. A palette is a subroutine that maps $z$ values to colors. A number of example palette subroutines are included in the library "color.gle".

The following example is a color map of a two dimensional Gaussian.

```
include "color.gle"

sub gauss x y
   s = 0.75
   return exp(-(x^2+y^2)/(2*s^2))
end sub

begin graph
   title "2D Gaussian"
   xaxis min -2 max 2
   yaxis min -2 max 2
   colormap gauss(x,y) 200 200 zmin 0 zmax 1 color
end graph

amove xg(xgmax)+0.3 yg(ygmin)
color_range_vertical 0 1 0.1 format "fix 1"
```



# Chapter 9

# GLE Utilities

## 9.1 Fitls

The FITLS utility allows an equation with $n$ unknown constants to be fitted to experimental data.

For example to fit a simple least squares regression line to a set of points you would give FITLS the equation: `a*x+b`

FITLS would then solve the equation to find the *best* values for the constants $a$ and $b$.

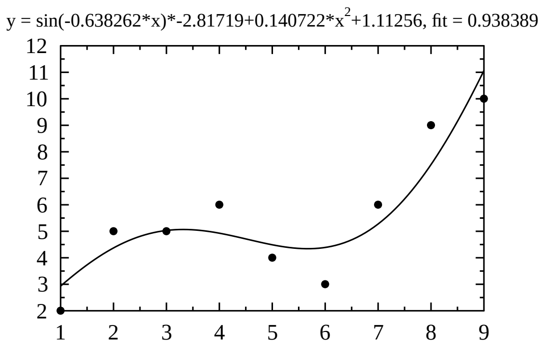
FITLS can work with non linear equations, it will ask for initial values for the parameters so that a solution around those initial guesses will be found.

FITLS writes out a GLE file containing commands to draw the data points and the equation it has fitted to them.

Here is a sample FITLS session:

```
$ fitls
Input data file (x and y columns optional) [test.dat,1,2] ? fitls.dat
Loading data from file, fitls.dat,  xcolumn=1, ycolumn=2
Valid operators: +, -, *, /, ^ (power)
Valid functions:
        abs(), atn(), cos(), exp(), fix(), int()
        log(), log10(), not(), rnd(), sgn(), sin()
        sqr(), sqrt(), tan()

 Enter a function of 'x' using constants 'a'...'z'
 e.g.    a + b*x   (standard linear least squares fit)
         sin(x)*a+b
         a + b*x + c*x^2 + d*x^3
         log(a*x)+(b+x)*c+a

Equation ? sin(a*x)*b+c*x^2+d

Output file name to write gle file [fitls.gle] ?
Precision of fit required, [1e-4] ?
Initial value for constant a [1.0] ?
Initial value for constant b [1.0] ?
Initial value for constant c [1.0] ?
Initial value for constant d [1.0] ?
```

```
0 evaluations, 1 1 1 1 , fit = 1355.36
20 evaluations, 1.97005 1 1 1 , fit = 1281.95
40 evaluations, 1.97005 10.228 0.151285 1 , fit = 54.7694
60 evaluations, 2.01053 10.228 0.151285 1.06365 , fit = 54.1771
.
.
.
440 evaluations, -0.640525 -2.81525 0.13997 1.13871 , fit = 0.940192
460 evaluations, -0.638055 -2.82934 0.140971 1.10502 , fit = 0.93842
480 evaluations, -0.63808 -2.82357 0.140993 1.10452 , fit = 0.938389
a = -0.638262 b = -2.81719 c = 0.140722 d = 1.11256

10 Iterations, sum of squares devided by n = 0.938389
y = sin(-0.638262*x)*-2.81719+0.140722*x^2+1.11256
```



## 9.2 Manip

Manip is a data manipulation package. It reads in a text file of numbers and displays them like a spreadsheet. You can then do simple operations on the columns and write them out in any format you like.

### 9.2.1 Usage

```
    MANIP infile.dat -recover -step -commands c.log -single -size x y
```

–recover

Manip logs everything you type to a file called `MANIP_.J1` When you use the -RECOVER option on the manip command it then reads keys from that file as if they were typed at the keyboard.

This will restore you to the point just before your pc crashed. The last three journal files are stored (.j1 .j2 .j3) simply copy the one you want to (.j1) to use it.

–step

Used with recover, press a space for each key you want to read from the journal file, press any other key to stop reading the journal.

–commands *filename.man*

This reads the commands in *filename.man* as if they were typed at the keyboard.

–single

This makes MANIP use single precision arithmetic and doesn't store strings at all, this enables three times as much data in the same amount of memory

–size *x y*

Sets the initial size of the spreadsheet. Use this with large datasets as it prevents the heap from becoming fragmented and thus lets you use much larger datasets.

**Range**

Most manip commands accept a range as one or more of there parameters. A range is a rectangular section of your spreadsheet. A range can ether start with a 'c' or an 'r' and this will affect how the command operates.

If your spreadsheet has 5 columns and 10 rows then.

```
c1 ==  c1c1r1r10  == 1,1  1,2  1,3  1,4  1,5  1,6 ...
r1 ==  r1r1c1c5   == 1,1  2,1  3,1  4,1  5,1
c1c2 ==c1c2r1r10  == 1,1  2,1  1,2  2,2  3,1  3,2 ...
r1r2c3=r1r2c3c5   == 3,1  3,2  4,1  4,2  5,1  5,2
```

**Arrows**

The arrow keys normally move the data cursor, however if you are half way thru typing a command then, the left and right arrow keys allow you to edit the command. Use the PAGE-UP and PAGE-DOWN keys to recall your last command.

SHIFT arrow keys will jump 7 cells at a time for fast movement.

Further help is available on the following toppics via the HELP command e.g. "HELP COPY"

## 9.2.2 Manip Primitives (a summary)

@*mycmds*
Arrows
BLANK
CLEAR
CLOSE
COPY [*range*] [*range*] IF [*exp*]
DATA [*range*]
DELETE [*range*] IF [*exp*]
EXIT *filename* [*range*] –TAB –SPACE –COMMA
FIT *c3*
Functions
GENERATE [*pattern*] [*destination*]
GOTO *x y*
INSERT [C*n*] or [R*n*]
LOAD *filename* [*range*] –0
LOAD *filename* [*range*]
LOGGING *mycmds.man*
MOVE [*range*] [*range*] IF [*exp*]
NEW
PARSUM [*range1*] [*range2*]

PROP [*range*] [*range*]
QUIT
Recover (recovering from power failure or crash)
SAVE *filename* [*range*] –TAB –SPACE –COMMA
SET SIZE *ncols nrows*
SET BETWEEN " "
SET COLTYPE
SET COLWIDTH
SET NCOL *n*
SET DPOINTS *n*
SET DIGITS *n*
SET WIDTH *n*
SHELL
SORT [*range*] on [*exp*]
SUM [*range*]
SWAP C*n*C*n* — R*n*R*n*

### 9.2.3 Manip Primitives (in detail)

COPY [*range1*] [*range2*] if [*exp*]

For copying a section to another section. They do not have to be the same shape. The pointers to both rangers are increased even if the number is not coppied e.g.

```
"% COPY r4r2 r1r2"
"% COPY c1c3r6r100  c6c8 if c1<c2"

"% COPY C1 C2 IF C1<4"
c1  c2
1       1
2       2
5       -
3       3
9       -
```

DELETE [*range*] IF [*exp*]

For deleteing entire rows or columns. e.g.

```
"% DELETE c1c3 IF r1>3.and.r2=0
"% DELETE r1"
```

Numbers are shuffled in from the right to take the place of the deleted range.

DATA [*range*]

Data entry mode is usefull for entering data. After typing in `"% DATA c1c3"` or `"% DATA C2"` you can then enter data and pressing ¡cr¿ will move you to the next valid data position. In this mode text or numbers can be entered. Press ESC to get back to command mode.

FIT *c3*

`"FIT C3"` will fit a least squares regression line to the data in columns c3 and c4 (x values taken from c3) and print out the results.

EXIT

EXIT saves the data in your input file spec and exits to DOS. You can optionally specify an output file as well. eg. `"% EXIT myfile.dat"`

The command `"EXIT myfile.dat c3c5r1r3"` will write out that range of numbers to the file.

By default manip will write columns seperated by spaces.

The command `"EXIT myfile.dat -TAB"` will put a single tab between each column of numbers and `"EXIT myfile.dat -COMMA"` will put a comma and a space between each number. (these two options are usefull if your data file is very big and you don't want to waste diskspace with the space characters.) Note: The settings stay in effect for future saves and exits.

You can make it line up the columns on the decimal point by typing in the command. `"SET DPOINTS 3"`

You change the width of each column or completely remove the spaces between columns with the command. `"SET WIDTH 10"` (or set width 0)

You can change the number of significant digits displayed with the command `"SET DIGITS 4"`

SAVE *myfile.dat*

Saves all or part of your data. The command `"SAVE myfile.dat c3c5r1r3"` will write out that range of numbers to the file.

By default manip will write columns seperated by spaces.

The command `"SAVE myfile.dat -TAB"` will put a single tab between each column of numbers and `"SAVE myfile.dat -COMMA"` will put a comma and a space between each number. (these two options are usefull if your data file is very big and you don't want to waste diskspace with the space characters).

Further options are the same like EXIT

GOTO

For moving the cursor directly to a point in your array. e.g. `"% GOTO x y"`

CLEAR

`"% CLEAR C2C3"` Clears the given range of all values

BLANK

`"% BLANK C2C3"` Clears the given range of all values

NEW

Clears the spread sheet of all data and frees memory.

INSERT

Inserts a new column or row and shifts all others over. e.g.`"% INSERT c5" or "% INSERT r2"`.

LOAD

Load data into columns. eg. `"% LOAD filename"` loads all data into corresponding columns. `"% LOAD filename c3"` load first column of data into c3 etc.

`"LOAD myfile.dat c3 -LIST"` This commmand will load the the data into a single column or range (even if it is several columns wide in the data file)

MOVE [*range1*] [*range2*] if [*exp*]

For copying a section to another section. They do not have to be the same shape. The pointer to the destination is only increased if the line or column is coppied e.g.

```
"% MOVE c1 c2c3"
"% MOVE r4r2 r1r2"
"% MOVE c1c3r6r100  c6c8 if c1<c2"

"% MOVE C1 C2 IF C1<4"
c1  c2
1       1
2       2
5       3
3       -
9       -

(See COPY command)
```

SORT [*range*] ON [*exp*]

Sort entire rows of the data based on the data in a particular column. e.g.

```
"% SORT c8 on c9"
"% SORT c1c8 on -c8"
"% SORT c1c3 on c2  "  !for sorting strings
```

This command works out how to sort the column (or exp) specified in the ON part of the command. It then does that operation to the range specified. e.g. `"SORT C1 ON C1"` will sort column one.

Use the additional qualifier `-STRINGS` if you want to sort a column with strings in it. e.g. `"sort c1 on c2 -strings"`

SWAP
: Swap over two columns or rows. e.g.

```
  "% SWAP c1c2"
"% SWAP r3r1"
```

SET SIZE *ncols nrows*
: `"SIZE 3 4"` Truncates the spreadsheet to 3 columns and 4 rows. This also sets the values to use for default ranges.

SET BETWEEN " "
: `"SET BETWEEN "##"` Defines the string to be printed between each column of numbers when written to a file. This is normally set to a single space.

SET COLWIDTH
: Set the width of each column when displayed. e.g. `"% SET COLWIDTH 12"`

SET COLTYPE [*n*] DECIMAL — EXP — BOTH — DPOINTS *n*
: This commands allows all or individual columns to be set to different output types. If colnumber is missing then that setting is applied to all columns.

`SET COLTYPE Ccolnumber TYPE` Where TYPE is one of:

```
DECIMAL    produces  123.456
EXP    produces 1.23456e02
BOTH       produces whichever is more suitable
DPOINTS n  produces a fixed number of decimal places.
 e.g.
SET COLTYPE c2 DECIMAL
SET COLTYPE c1 EXP
SET COLTYPE c3 DPOINTS 4
```

Would print out: `1.2e02    1.2    1.2000`

```
SET COLTYPE EXP   (column number missed out)
```

Would print out: `1.2e02    1.2e02  1.2e02`

SET NCOL *n*
: Set the number of columns to display. e.g.`"% SET NCOL 3"`

SET DPOINTS *n*
: Sets the number of decimal places to print. This is used for producing columns which line up on the decimal point. e.g. with `DPOINTS 3`.

```
2.2   ->   2.200
234   -> 234.000
```

(See also SET COLTYPE)

SET DIGITS *n*
: Sets the number of significat digits to be displayed, e.g. with `DIGITS 3`.

```
123456    becomes   123000
0.12345   becomes   0.123
```

SET WIDTH *n*

Sets the width of padding to use for the columns when they are written to a file. The columns usually one space wider than this setting as the BETWEEN string is usually set to one space by default.

LOGGING

For creating command files. e.g.

```
"% LOG sin.man"
"% c2=sin(c1)
"% c3=c2+2
"% close"
```

Then type in `"@sin"` to execute these commands.

PROPAGATE [*source*] [*destination*]

This command has the same format as move. The difference is that the source is coppied as many times as possible to fill up the destination. e.g. `"% PROP c1r1r7 c2"`

SUM [*range*]

Adds up all the numbers in a range and displays the total and average. e.g. `"% SUM C1C3"`

PARSUM [*range1*] [*range2*]

Adds up one coloumn, putting the partial sum's into another coloumn. e.g. `1,2,3,4` becomes `1,3,6,10`.

GENERATE [*pattern*] [*destination*]

For generating a patter of data e.g. `1 1 2 2 5 5 1 1 2 2 5 5` etc.

```
"% GEN 2(1,2,5)30 c4" !1 1 2 2 5 5  repeated 30 times
"% GEN (1:100:5)5 c1" !1 to 100 step 5,  5 times
"% GEN (1,2,*,3:5)5 c1" !missing values included
```

Functions

Calculations can be performed on rows or columns. eg `"% C1=C2*3+R"` where "R" stands for row-number and C1 and C2 are columns. They can also be performed on ROWS. eg

```
r1=sin(r2)+log10(c)
c1 = cell(c+1,r)+cell(c+2,r)
cell(1,3) = 33.3
3+4*COS(PI/180)^(3+1/30)+C1+R
```

Valid operators and functions:

| | | | | | | |
|---|---|---|---|---|---|---|
| , | + | − | ˆ | ∗ | / | <= |
| >= | <> | < | > | = | )AND( | )OR( |
| ABS( | ATN( | COS( | EXP( | FIX( | INT( | LOG( |
| LOG10( | SGN( | SIN( | SQR( | TAN( | NOT( | RND( |
| SQRT( | .NE. | .EQ. | .LT. | .GT. | .LE. | .GE. |
| .NOT. | .AND. | .OR. | | | | |

QUIT

Abandon file.

SHELL

Gives access to DOS.

# Appendix A

# Tables

## A.1 Markers

| | | | | |
|---|---|---|---|---|
| △ triangle | ● fcircle | ⊙ odot | ✿ flower | ✍ handpen |
| △ wtriangle | ◇ diamond | ⊖ ominus | ♣ club | ✉ letter |
| ▲ ftriangle | ◇ wdiamond | ⊕ oplus | ♡ heart | ☎ phone |
| □ square | ◆ fdiamond | ⊗ otimes | ♠ spade | ✈ plane |
| □ wsquare | × cross | ★ star | † dag | ❍ scircle |
| ■ fsquare | + plus | ✥ star2 | ‡ ddag | ❑ ssquare |
| ○ circle | — minus | ✫ star3 | § snake | △ trianglez |
| ○ wcircle | ∗ asterisk | ✹ star4 | • dot | ♢ diamondz |

## A.2 Functions and Variables

| Function name | Returns ... |
|---|---|
| `abs(exp)` | absolute value of expression |
| `acos(exp)` | arccosine |
| `acosh(exp)` | inverse hyperbolic cosine |
| `acot(exp)` | 1/atan(exp) |
| `acoth(exp)` | 1/atanh(exp) |
| `acsc(exp)` | 1/asin(exp) |
| `acsch(exp)` | 1/asinh(exp) |
| `arg(i)` | i-th command line argument |
| `arg$(i)` | i-th command line argument |
| `asec(exp)` | 1/acos(exp) |
| `asech(exp)` | 1/acosh(exp) |
| `asin(exp)` | arcsine |
| `asinh(exp)` | inverse hyperbolic sine |
| `atan(exp)` | arctan |

| | |
|---|---|
| `atanh(exp)` | inverse hyperbolic tangent |
| `atn(exp)` | same as ATAN(exp) |
| `cos(exp)` | cosine |
| `cosh(exp)` | hyperbolic cosine |
| `cot(exp)` | 1/tan(exp) |
| `coth(exp)` | 1/tanh(exp) |
| `csc()` | 1/sin(exp) |
| `csch(exp)` | 1/sinh(exp) |
| `date$()` | current date e.g. “Tue Apr 09 1991” |
| `device$()` | available devices e.g. “HARDCOPY, PS” |
| `eval(str)` | evaluates given GLE expression |
| `exp(exp)` | exponent |
| `\expr(exp)` | substitute result of evaluating “exp” |
| `fix(exp)` | `exp` rounded towards 0 |
| `format$(exp,format)` | format `exp` as specified in `format` (page 38) |
| `height(name$)` | the height of the object `name$` |
| `int(exp)` | integer part of `exp` |
| `left$(str$,exp)` | left `exp` characters of `str$` |
| `len(str$)` | the length of `str$` |
| `log(exp)` | log to base *e* of `exp` |
| `log10(exp)` | log to base 10 of `exp` |
| `nargs()` | number of command line arguments |
| `not(exp)` | logical not of `exp` |
| `num1$(exp)` | as above but with no spaces |
| `num$(exp)` | string representation of `exp` |
| `pageheight()` | the height of the page (from size command) |
| `pagewidth()` | the width of the page (from size command) |
| `pointx(pt)` | the x value of point pt |
| `pointy(pt)` | the y value of point pt |
| `pos(str1$,str2$,exp)` | position of `str2$` in `str1$` from `exp` |
| `ptx(pt)` | the x value of point pt |
| `pty(pt)` | the y value of point pt |
| `rgb(red,green,blue)` | create color given RGB values |
| `rgb255(red,green,blue)` | create color given RGB values |
| `right$(str$,exp)` | rest of `str$` starting at `exp` |
| `rnd(exp)` | random number from seed `exp` |
| `sec(exp)` | 1/cos(exp) |
| `sech(exp)` | 1/cosh(exp) |
| `seg$(str$,exp1,exp2)` | `str$` from `exp1` to `exp2` |
| `sgn(exp)` | returns 1 if `exp` is positive, -1 if `exp` is negative |
| `sin(exp)` | sine of `exp` |
| `sinh(exp)` | hyperbolic sine |
| `sqr(exp)` | `exp` squared |
| `sqrt(exp)` | square root of `exp` |

| | |
|---|---|
| `tan(exp)` | tangent of `exp` |
| `tanh(exp)` | hyperbolic tangent |
| `tdepth(str$)` | the depth of `str$` assuming current the font, size |
| `theight(str$)` | the height of `str$` assuming current font, size |
| `time$()` | current time e.g. “11:44:27” |
| `todeg(exp)` | convert from radians to degrees |
| `torad(exp)` | convert from degrees to radians |
| `twidth(str$)` | the width of `str$` assuming current font, size |
| `val(str$)` | value of the string `str$` |
| `width(name$)` | the width of the object `name$` |
| `xend()` | the x end point of a text string when drawn |
| `xg(xexp)` | converts units of last graph to abs cm. |
| `xpos()` | the current x point |
| `yend()` | the y end point of a text string when drawn |
| `yg(yexp)` | converts units of last graph to abs cm. |
| `ypos()` | the current y point |

| Variable name | Returns ... |
|---|---|
| `pi` | 3.14... |
| `xgmin` | the minimum x-coordinate of the graph |
| `xgmax` | the maximum x-coordinate of the graph |
| `xg2min` | the minimum x2-coordinate of the graph |
| `xg2max` | the maximum x2-coordinate of the graph |
| `ygmin` | the minimum y-coordinate of the graph |
| `ygmax` | the maximum y-coordinate of the graph |
| `yg2min` | the minimum y2-coordinate of the graph |
| `yg2max` | the maximum y2-coordinate of the graph |

## A.3 LaTeX Macros and Symbols

There are several LaTeX like commands which can be used within text, they are:

```
\ \' \v \u \= \^     Implemented TeX accents
\. \H \~ \''
^{}                  Superscript
_{}                  Subscript
\\                   Forced Newline
\_                   Underscore character
\,                   .5em (em = width of the letter 'm')
\:                   1em space
\;                   2em space
\tex{expression}     Any LaTeX expression
\char{22}            Any character in current font
\chardef{a}{hello}   Define a character as a macro
\def\v{hello}        Defines a macro
\movexy{2}{3}        Moves the current text point
\glass               Makes move/space work on beginning of line
\rule{2}{4}          Draws a filled in box, 2cm by 4cm
\setfont{rmb}        Sets the current text font
\sethei{.3}          Sets the font height (in cm)
\setstretch{2}       Scales the quantity of glue between words
\lineskip{.1}        Sets the default distance between lines of text
\linegap{-1}         Sets the minimum required gap between lines
```

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| [ | \lbrack | ß | \ss | $\geq$ | \geq | † | \dag | ‡ | \ddag |
| § | \S | ¶ | \P | © | \copyright | $\alpha$ | \alpha | $\beta$ | \beta |
| $\gamma$ | \gamma | $\delta$ | \delta | $\epsilon$ | \epsilon | $\zeta$ | \zeta | $\eta$ | \eta |
| $\theta$ | \theta | $\iota$ | \iota | $\kappa$ | \kappa | $\lambda$ | \lambda | $\mu$ | \mu |
| $\nu$ | \nu | $\xi$ | \xi | $\pi$ | \pi | $\rho$ | \rho | $\sigma$ | \sigma |
| $\tau$ | \tau | $\upsilon$ | \upsilon | $\phi$ | \phi | $\chi$ | \chi | $\psi$ | \psi |
| $\omega$ | \omega | $\varepsilon$ | \varepsilon | $\vartheta$ | \vartheta | $\varpi$ | \varpi | $\varrho$ | \varrho |
| $\varsigma$ | \varsigma | $\varphi$ | \varphi | $\aleph$ | \aleph | $\imath$ | \imath | $\jmath$ | \jmath |
| $\ell$ | \ell | $\wp$ | \wp | $\Re$ | \Re | $\Im$ | \Im | $\partial$ | \partial |
| $\infty$ | \infty | $\prime$ | \prime | $\emptyset$ | \emptyset | $\nabla$ | \nabla | $\top$ | \top |
| $\bot$ | \bot | $\triangle$ | \triangle | $\forall$ | \forall | $\exists$ | \exists | $\neg$ | \neg |
| $\flat$ | \flat | $\natural$ | \natural | $\sharp$ | \sharp | $\clubsuit$ | \clubsuit | $\diamondsuit$ | \diamondsuit |
| $\heartsuit$ | \heartsuit | $\spadesuit$ | \spadesuit | $\coprod$ | \coprod | $\bigvee$ | \bigvee | $\bigwedge$ | \bigwedge |
| $\biguplus$ | \biguplus | $\bigcap$ | \bigcap | $\bigcup$ | \bigcup | $\prod$ | \prod | $\sum$ | \sum |
| $\bigotimes$ | \bigotimes | $\bigoplus$ | \bigoplus | $\bigodot$ | \bigodot | $\bigsqcup$ | \bigsqcup | $\smallint$ | \smallint |
| $\intop$ | \intop | $\ointop$ | \ointop | $\triangleleft$ | \triangleleft | $\triangleright$ | \triangleright | $\bigtriangleup$ | \bigtriangleup |
| $\bigtriangledown$ | \bigtriangledown | $\wedge$ | \wedge | $\land$ | \land | $\vee$ | \vee | $\lor$ | \lor |
| $\cap$ | \cap | $\cup$ | \cup | $\ddagger$ | \ddagger | $\dagger$ | \dagger | $\sqcap$ | \sqcap |
| $\sqcup$ | \sqcup | $\uplus$ | \uplus | $\amalg$ | \amalg | $\diamond$ | \diamond | $\bullet$ | \bullet |
| $\wr$ | \wr | $\div$ | \div | $\odot$ | \odot | $\oslash$ | \oslash | $\otimes$ | \otimes |
| $\ominus$ | \ominus | $\oplus$ | \oplus | $\mp$ | \mp | $\pm$ | \pm | $\circ$ | \circ |
| $\bigcirc$ | \bigcirc | $\setminus$ | \setminus | $\cdot$ | \cdot | $\ast$ | \ast | $\times$ | \times |
| $\star$ | \star | Å | \AA | | | | | | |

## A.4 Installing GLE

## A.5 Fonts

| | | | |
|---|---|---|---|
| rm | Roman | psagb | AvantGarde-Book |
| rmb | **Roman Bold** | psagbo | *AvantGarde-BookOblique* |
| rmi | *Roman Italic* | psagd | **AvantGarde-Demi** |
| ss | Sans Serif | psagdo | ***AvantGarde-DemiOblique*** |
| ssb | **Sans Serif Bold** | psbd | **Bookman-Demi** |
| ssi | *Sans Serif Italic* | psbdi | ***Bookman-DemiItalic*** |
| tt | Typewriter | psbli | *Bookman-LightItalic* |
| ttb | **Typewriter Bold** | psc | Courier |
| tti | *Typewriter Italic* | pscb | **Courier-Bold** |
| | | pscbo | ***Courier-BoldOblique*** |
| | | psco | *Courier-Oblique* |
| texcmb | **Computer Modern Bold** | psh | Helvetica |
| texcmitt | *Computer Modern Italic Typewriter* | pshb | **Helvetica-Bold** |
| texcmmi | *ComputerModernMathsItalic* | pshbo | ***Helvetica-BoldOblique*** |
| texcmr | Computer Modern Roman | psho | *Helvetica-Oblique* |
| texcmss | Computer Modern Sans Serif | pshc | Helvetica-Condensed |
| texcmssb | **Computer Modern Sans Serif Bold** | pshcb | **Helvetica-Condensed-Bold** |
| texcmssi | *Computer Modern Sans Serif Italic* | pshcdo | *Helvetica-Condensed-BoldOblique* |
| texcmti | *Computer Modern Text Italic* | pshn | Helvetica-Narrow |
| texcmtt | Computer Modern Typewriter Text | pshnb | **Helvetica-Narrow-Bold** |
| | | pshnbo | ***Helvetica-Narrow-BoldOblique*** |
| | | pshno | *Helvetica-NarrowOblique* |
| plba | Block Ascii | psncsb | **NewCenturySchlbk-Bold** |
| plci | *Complex Italic* | psncsbi | ***NewCenturySchlbk-BoldItalic*** |
| plcr | Complex Roman | psncsi | *NewCenturySchlbk-Italic* |
| plcs | *Complex Script* | psncsr | NewCenturySchlbk-Roman |
| pldr | Duplex Roman | pspb | **Palatino-Bold** |
| plge | **Gothic English** | pspbi | ***Palatino-BoldItalic*** |
| plgg | **Gothic German** | pspi | *Palatino-Italic* |
| plgi | **Gothic Italian** | pspr | Palatino-Roman |
| plsa | Simplex Ascii | pssym | Σψμβολ |
| plsg | Τινπμεω Ηεσναξ | pstb | **Times-Bold** |
| plsr | Simplex Roman | pstbi | ***Times-BoldItalic*** |
| plss | *Simplex Script* | psti | *Times-Italic* |
| plti | *Triplex Italic* | pstr | Times-Roman |
| pltr | Triplex Roman | pszcmi | *ZapfChancery-MediumItalic* |

## A.6 Font Tables

Roman (rm)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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San Serif (ss)

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San Serif Bold (ssb)

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San Serif Italic (ssi)

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| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
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| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
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Typewriter (tt)

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| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ∧ | ¯ | ʻ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | i | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | ″ | « | ‹ | › | fi | fl | ° | – | † | ‡ |
| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
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| 22 | Ü | Ý | Þ | ß | à | Æ | â | ª | ä | å | æ | ç | Ł | Ø | Œ | º | ì | í | î | ï |
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Typewriter Bold (ttb)

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| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ∧ | ¯ | ʻ | a | b | c |
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| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
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Typewriter Italic (tti)

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TEXComputer Modern Bold (texcmb)

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| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | “ | ] | ˆ | ˙ | ‘ | a | b | c |
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| 24 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | | Δ | Θ | Λ |

TEXComputer Modern Extensible (texcmex)

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| 0 | ( | ) | [ | ] | ⌊ | ⌋ | ⌈ | ⌉ | { | } | ⟨ | ⟩ | \| | ‖ | / | \ | ( | ) | ( | ) |
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| 6 | ⎨ | ⎬ | ⎪ | ⎪ | ⎝ | ⎠ | ⎜ | ⎟ | ⟨ | ⟩ | ⊔ | ⊔ | ∮ | ∮ | ⊙ | ⊙ | ⊕ | ⊕ | ⊗ | ⊗ |
| 8 | ∑ | ∏ | ∫ | ⋃ | ⋂ | ⊎ | ⋀ | ⋁ | ∑ | ∏ | ∫ | ⋃ | ⋂ | ⊎ | ⋀ | ⋁ | ∐ | ∐ | ˆ | ︿ |
| 10 | ︿ | ˜ | ~ | ~ | [ | ] | ⌊ | ⌋ | ⌈ | ⌉ | { | } | √ | √ | √ | √ | ⎷ | \| | ⌜ | ‖ |
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| 18 | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( |
| 20 | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( |
| 22 | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( | ( |
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TEXComputer Modern Italic Typewriter (texcmitt)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 22 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
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TEXComputer Modern Maths Italic (texcmmi)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Γ | Δ | Θ | Λ | Ξ | Π | Σ | Υ | Φ | Ψ | Ω | α | β | γ | δ | ϵ | ζ | η | θ | ι |
| 2 | κ | λ | μ | ν | ξ | π | ρ | σ | τ | υ | ϕ | χ | ψ | ω | ε | ϑ | ϖ | ϱ | ς | φ |
| 4 | ↼ | ↽ | ⇀ | ⇁ | ‘ | ’ | ▷ | ◁ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | · | , |
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| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | ı | ȷ | ℘ | → | ⁀ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 14 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
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TEXComputer Modern Roman (texcmr)

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TEXComputer Modern Sans Serif (texcmss)

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| 14 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
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TEXComputer Modern Sans Serif Bold (texcmssb)

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| 0 | **Γ** | **Δ** | **Θ** | **Λ** | **Ξ** | **Π** | **Σ** | **Υ** | **Φ** | **Ψ** | **Ω** | **ﬀ** | **ﬁ** | **ﬂ** | **ﬃ** | **ﬄ** | **ı** | **ȷ** | ` | ´ |
| 2 | ˇ | ˘ | ¯ | ˚ | ¸ | **ß** | **æ** | **œ** | **ø** | **Æ** | **Œ** | **Ø** | - | **!** | **”** | **#** | **$** | **%** | **&** | **’** |
| 4 | **(** | **)** | * | **+** | **,** | **-** | **·** | **/** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **:** | **;** |
| 6 | **¡** | **=** | **¿** | **?** | **@** | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** | **N** | **O** |
| 8 | **P** | **Q** | **R** | **S** | **T** | **U** | **V** | **W** | **X** | **Y** | **Z** | **[** | **“** | **]** | ˆ | ˙ | **‘** | **a** | **b** | **c** |
| 10 | **d** | **e** | **f** | **g** | **h** | **i** | **j** | **k** | **l** | **m** | **n** | **o** | **p** | **q** | **r** | **s** | **t** | **u** | **v** | **w** |
| 12 | **x** | **y** | **z** | – | — | ˝ | ˜ | ¨ | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** |
| 14 | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** |
| 16 | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** |
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| 24 | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | **Γ** | | **Δ** | **Θ** | **Λ** |

TEXComputer Modern Sans Serif Italic (texcmssi)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | *Γ* | *Δ* | *Θ* | *Λ* | *Ξ* | *Π* | *Σ* | *Υ* | *Φ* | *Ψ* | *Ω* | *ﬀ* | *ﬁ* | *ﬂ* | *ﬃ* | *ﬄ* | *ı* | *ȷ* | ` | ´ |
| 2 | ˇ | ˘ | ¯ | ˚ | ¸ | *ß* | *æ* | *œ* | *ø* | *Æ* | *Œ* | *Ø* | - | *!* | ” | # | *$* | *%* | *&* | ’ |
| 4 | *(* | *)* | * | + | , | - | · | / | *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | : | ; |
| 6 | *¡* | = | *¿* | *?* | *@* | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* | *K* | *L* | *M* | *N* | *O* |
| 8 | *P* | *Q* | *R* | *S* | *T* | *U* | *V* | *W* | *X* | *Y* | *Z* | [ | “ | ] | ˆ | ˙ | ‘ | *a* | *b* | *c* |
| 10 | *d* | *e* | *f* | *g* | *h* | *i* | *j* | *k* | *l* | *m* | *n* | *o* | *p* | *q* | *r* | *s* | *t* | *u* | *v* | *w* |
| 12 | *x* | *y* | *z* | – | — | ˝ | ˜ | ¨ | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* |
| 14 | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* |
| 16 | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* |
| 18 | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* |
| 20 | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* |
| 22 | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* |
| 24 | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | *Γ* | | · | × | ∗ |

TEXComputer Modern Symbol (texcmsy)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | − | · | × | ∗ | ÷ | ⋄ | ± | ∓ | ⊕ | ⊖ | ⊗ | ⊘ | ⊙ | ◯ | ∘ | • | ≍ | ≡ | ⊆ | ⊇ |
| 2 | ≤ | ≥ | ⪯ | ⪰ | ∼ | ≈ | ⊂ | ⊃ | ≪ | ≫ | ≺ | ≻ | ← | → | ↑ | ↓ | ↔ | ↗ | ↘ | ≃ |
| 4 | ⇐ | ⇒ | ⇑ | ⇓ | ⇔ | ↖ | ↙ | ∝ | ′ | ∞ | ∈ | ∋ | △ | ▽ | / | ˈ | ∀ | ∃ | ¬ | ∅ |
| 6 | ℜ | ℑ | ⊤ | ⊥ | ℵ | 𝒜 | ℬ | 𝒞 | 𝒟 | ℰ | ℱ | 𝒢 | ℋ | ℐ | 𝒥 | 𝒦 | ℒ | ℳ | 𝒩 | 𝒪 |
| 8 | 𝒫 | 𝒬 | ℛ | 𝒮 | 𝒯 | 𝒰 | 𝒱 | 𝒲 | 𝒳 | 𝒴 | 𝒵 | ∪ | ∩ | ⊎ | ∧ | ∨ | ⊢ | ⊣ | ⌊ | ⌋ |
| 10 | ⌈ | ⌉ | { | } | ⟨ | ⟩ | \| | ‖ | ↕ | ⇕ | \ | ≀ | √ | ⨿ | ∇ | ∫ | ⊔ | ⊓ | ⊑ | ⊒ |
| 12 | § | † | ‡ | ¶ | ♣ | ♢ | ♡ | | − | − | − | − | − | − | − | − | − | − | − | − |
| 14 | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − |
| 16 | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − |
| 18 | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − |
| 20 | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − |
| 22 | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − |
| 24 | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | − | | · | × | ∗ |

### TEXComputer Modern Text Italic (texcmti)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Γ | Δ | Θ | Λ | Ξ | Π | Σ | Υ | Φ | Ψ | Ω | ff | fi | fl | ffi | ffl | ı | ȷ | ` | ´ |
| 2 | ˇ | ˘ | ¯ | ˚ | ¸ | ß | æ | œ | ø | Æ | Œ | Ø | - | ! | ” | # | £ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | ¡ | = | ¿ | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | “ | ] | ˆ | ˙ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | – | — | ˝ | ˜ | ¨ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 14 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 16 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 18 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 20 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 22 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 24 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | | Δ | Θ | Λ |

### TEXComputer Modern Typewriter Text (texcmtt)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Γ | Δ | Θ | Λ | Ξ | Π | Σ | Υ | Φ | Ψ | Ω | ↑ | ↓ | ' | ¡ | ¿ | ı | ȷ | ` | ´ |
| 2 | ˇ | ˘ | ¯ | ˚ | ¸ | ß | æ | œ | ø | Æ | Œ | Ø | ␣ | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | - | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | ¨ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 14 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 16 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 18 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 20 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 22 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ |
| 24 | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | Γ | | Δ | Θ | Λ |

### Plotter Block Ascii (plba)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | " | # | $ | % | & | ' |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | - | ` | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | ¦ | } | ~ | ⇦ | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | | ! | ! | ! |

### Plotter Complex Cartographic (plcc)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ″ | ± | * | % | ∓ | ′ |
| 4 | ( | ) | ⟩ | { | , | ] | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | } | > | ? | @ | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| 8 | П | Р | С | Т | У | Ф | Х | Ц | Ч | Ш | Щ | [ | ! | ] | ! | ! | ‘ | а | б | в |
| 10 | г | д | е | ж | з | и | й | к | л | м | н | о | п | р | с | т | у | ф | х | ц |
| 12 | ч | ш | щ | { | [ | } | ∘ | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | | ! | ! | ! |

### Plotter Complex Gothic (plcg)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ″ | ± | * | % | ∓ | ′ |
| 4 | ( | ) | ⟩ | { | , | ] | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | } | > | ? | @ | Α | Β | Γ | Δ | Ε | Ζ | Η | Θ | Ι | Κ | Λ | Μ | Ν | Ξ | Ο |
| 8 | Π | Ρ | Σ | Τ | Υ | Φ | Χ | Ψ | Ω | *A* | *B* | [ | ! | ] | ! | ! | ‘ | α | β | γ |
| 10 | δ | ε | ζ | η | ϑ | ι | κ | λ | μ | ν | ξ | ο | π | ρ | σ | τ | υ | φ | χ | ψ |
| 12 | ω | a | b | { | [ | } | ∘ | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | | ! | ! | ! |

### Plotter Complex Italic (plci)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ″ | ± | * | % | ∓ | ′ |
| 4 | ( | ) | ⟩ | { | , | ] | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | } | > | ? | @ | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* | *K* | *L* | *M* | *N* | *O* |
| 8 | *P* | *Q* | *R* | *S* | *T* | *U* | *V* | *W* | *X* | *Y* | *Z* | [ | ! | ] | ! | ! | ‘ | *a* | *b* | *c* |
| 10 | *d* | *e* | *f* | *g* | *h* | *i* | *j* | *k* | *l* | *m* | *n* | *o* | *p* | *q* | *r* | s | *t* | *u* | *v* | *w* |
| 12 | *x* | *y* | *z* | { | [ | } | ∘ | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | | ! | ! | ! |

Plotter Complex Roman (plcr)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ″ | ± | ∗ | % | ∓ | ′ |
| 4 | ( | ) | ⟩ | { | ' | ] | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | } | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ! | ] | ! | ! | ' | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | [ | } | ° | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |  | ! | ! | ! |

Plotter Complex Script (plcs)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ″ | ± | ∗ | % | ∓ | ′ |
| 4 | ( | ) | ⟩ | { | ' | ] | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | } | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ! | ] | ! | ! | ' | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | [ | } | ° | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |  | ! | ! | ! |

Plotter Duplex Roman (pldr)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | , | ! | $ | % | ! | ' |
| 4 | ( | ) | ″ | + | ' | − | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ! | ] | ! | ! | ' | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | * | } | & | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |  | ! | ! | ! |

Plotter Gothic English (plge)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | , | ! | $ | % | ! | ' |
| 4 | ( | ) | ″ | + | ' | − | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ! | ] | ! | ! | ' | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | * | } | & | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |  | ! | ! | ! |

Plotter Gothic German (plgg)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | , | ! | $ | % | ! | ' |
| 4 | ( | ) | ″ | + | ' | − | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ! | ] | ! | ! | ' | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | ſ | t | u | v | w |
| 12 | x | y | z | { | * | } | & | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |  | ! | ! | ! |

Plotter Gothic Italian (plgi)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | , | ! | $ | % | ! | ' |
| 4 | ( | ) | ″ | + | ' | − | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ! | ] | ! | ! | ' | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | * | } | & | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |  | ! | ! | ! |

Plotter Simplex Ascii (plsa)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | " | # | $ | % | & | ' |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | - | ` | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | ← | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | | ! | ! | ! |

Plotter Simplex German (plsg)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | " | # | $ | % | & | ' |
| 4 | ( | ) | * | + | , | − | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | Γ | Δ | E | Z | H | Θ | I | K | Λ | M | N | Ξ | O |
| 8 | Π | P | Σ | T | Υ | Φ | X | Ψ | Ω | 𝒜 | ℬ | [ | ! | ] | ! | ! | ' | α | β | γ |
| 10 | δ | ε | ζ | η | ϑ | ι | κ | λ | μ | ν | ξ | ο | π | ρ | σ | τ | υ | φ | χ | ψ |
| 12 | ω | 𝒶 | 𝒷 | { | \| | } | ∘ | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | | ! | ! | ! |

Plotter Simplex Roman (plsr)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | " | # | $ | % | & | ' |
| 4 | ( | ) | * | + | , | − | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ! | ] | ! | ! | ' | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ° | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | | ! | ! | ! |

Plotter Simplex Script (plss)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | " | # | $ | % | & | ' |
| 4 | ( | ) | * | + | , | − | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | 𝒜 | ℬ | 𝒞 | 𝒟 | ℰ | ℱ | 𝒢 | ℋ | ℐ | 𝒥 | 𝒦 | ℒ | ℳ | 𝒩 | 𝒪 |
| 8 | 𝒫 | 𝒬 | ℛ | 𝒮 | 𝒯 | 𝒰 | 𝒱 | 𝒲 | 𝒳 | 𝒴 | 𝒵 | [ | ! | ] | ! | ! | ' | 𝒶 | 𝒷 | 𝒸 |
| 10 | 𝒹 | ℯ | 𝒻 | ℊ | 𝒽 | 𝒾 | 𝒿 | 𝓀 | 𝓁 | 𝓂 | 𝓃 | ℴ | 𝓅 | 𝓆 | 𝓇 | 𝓈 | 𝓉 | 𝓊 | 𝓋 | 𝓌 |
| 12 | 𝓍 | 𝓎 | 𝓏 | { | \| | } | ∘ | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | | ! | ! | ! |

Plotter Symbols one (plsym1)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ≈ | ≈ | ≅ | ⇄ | □ | • | ⅚ | ½ | ⅓ | ⅙ | ⅛ | ⅔ | ⅜ | ⅝ | ⅞ | ⅚ | ¼ | ¾ | ℒ | ® |
| 2 | © | ≢ | ⋯ | ↔ | ↕ | ⊄ | ⊅ | ∋ | ⦀ | ‖ | ⊥ | ∠ | ∴ | ♤ | ♡ | ♢ | ♧ | ☘ | ⚜ | S |
| 4 | ∿ | ∞ | ⇲ | ϭ | — | ╱ | │ | ╲ | — | ╱ | / | \| | \ | ╲ | – | ⁄ | ˈ | ˋ | ◜ | ◟ |
| 6 | ◞ | ◝ | ‿ | ( | ) | ⁀ | ɀ | ∿ | ᴎ | ℸ | ℓ | ∝ | ɤ | ꝏ | φ | φ | • | ) | -- | ⊓ |
| 8 | ^ | ⏚ | ▽ | ○ | □ | △ | ◇ | ☆ | + | × | ∗ | ● | ■ | ▲ | ◀ | ▼ | ▶ | ★ | ⚑ | ⚓ |
| 10 | † | ⚒ | ⛫ | ⛵ | ⛷ | ✙ | © | ✡ | 🔔 | 🌴 | 🌲 | 🌳 | 🌳 | ☀ | ⛉ | 🛡 | ¢ | ° | * | / |
| 12 | ( | ) | [ | ] | { | } | ⟨ | ⟩ | \| | ‖ | − | + | ± | ∓ | × | · | ÷ | = | ≠ | ≡ |
| 14 | < | > | ≦ | ≧ | ∝ | ∼ | ˆ | ˊ | ˋ | ˘ | , | ‘ | ʿ | ʾ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ |
| 16 | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ |
| 18 | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ |
| 20 | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ |
| 22 | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ |
| 24 | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | ≈ | | ᑫ | ∪ | ⊃ |

Plotter Symbols two (plsym2)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ⊂ | ⊂ | ∪ | ⊃ | ∩ | ∈ | → | ↑ | ← | ↓ | ∂ | ∇ | √ | ∫ | ∮ | ∞ | % | & | @ | $ |
| 2 | # | § | † | ‡ | ∃ | ☉ | ☿ | ♀ | ⊕ | ♂ | ♃ | ♄ | ⛢ | ♆ | ♇ | ☾ | ☄ | ✳ | ☊ | ☋ |
| 4 | ∏ | ∑ | ( | ) | [ | ] | { | } | ( | ) | √ | ∫ | → | ↑ | ← | ↓ | ∂ | ∇ | √ | ∫ |
| 6 | ∮ | ∞ | % | & | @ | $ | # | § | † | ‡ | ∃ | ☉ | ☿ | ♀ | ⊕ | ♂ | ♃ | ♄ | ⛢ | ♆ |
| 8 | ♇ | ☾ | ☄ | ✳ | ☊ | ☋ | ↗ | ↙ | ↖ | ↘ | ♈ | ♉ | ♊ | ♋ | ♌ | ♍ | ♎ | ♏ | ♐ | ♑ |
| 10 | ♒ | ♓ | · | ˎ | ˏ | 𝅝 | 𝅗 | ● | ♯ | ♮ | ♭ | ▬ | ▬ | 𝄽 | 𝄾 | 𝄞 | 𝄢 | 𝄡 | o | o |
| 12 | ● | ♯ | ♮ | ♭ | ▬ | ▬ | 𝄽 | 𝄾 | 𝄢 | 𝄡 | ∏ | ∑ | ( | ) | [ | ] | { | } | ( | ) |
| 14 | √ | ∫ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ |
| 16 | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ⊂ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ |
| 18 | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ |
| 20 | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ |
| 22 | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ |
| 24 | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | ᑫ | | ᑫ | ∪ | ⊃ |

Plotter Triplex Italic (plti)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | , | ! | $ | % | ! | ‘ |
| 4 | ( | ) | " | + | , | − | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ! | ] | ! | ! | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | * | } | & | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |  | ! | ! | ! |

Plotter Triplex Roman (pltr)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 2 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | , | ! | $ | % | ! | ‘ |
| 4 | ( | ) | " | + | , | − | · | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ! | ] | ! | ! | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | * | } | & | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 14 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 16 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 18 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 20 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 22 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |
| 24 | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! | ! |  | ! | ! | ! |

PostScript AvantGarde-Book (psagb)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | – | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
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PostScript AvantGarde-BookOblique (psagbo)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | – | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript AvantGarde-Demi (psagd)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | – | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript AvantGarde-DemiOblique (psagdo)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | – | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript Bookman-Demi (psbd)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
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| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
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PostScript Bookman-DemiItalic (psbdi)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
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| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript Bookman-LightItalic (psbli)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
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| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
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PostScript Courier (psc)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
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| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | ° | – | † | ‡ |
| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | É | ˚ | ¸ | Ì | ˝ | ˛ | ˇ | — | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û |
| 22 | Ü | Ý | Þ | ß | à | Æ | â | ª | ä | å | æ | ç | Ł | Ø | Œ | º | ì | í | î | ï |
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PostScript Courier-Bold (pscb)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | ° | – | † | ‡ |
| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | É | ˚ | ¸ | Ì | ˝ | ˛ | ˇ | — | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û |
| 22 | Ü | Ý | Þ | ß | à | Æ | â | ª | ä | å | æ | ç | Ł | Ø | Œ | º | ì | í | î | ï |
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PostScript Courier-BoldOblique (pscbo)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | ° | – | † | ‡ |
| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
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| 22 | Ü | Ý | Þ | ß | à | Æ | â | ª | ä | å | æ | ç | Ł | Ø | Œ | º | ì | í | î | ï |
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PostScript Courier-Oblique (psco)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | þ | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | ° | – | † | ‡ |
| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | É | ˚ | ¸ | Ì | ˝ | ˛ | ˇ | — | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û |
| 22 | Ü | Ý | Þ | ß | à | Æ | â | ª | ä | å | æ | ç | Ł | Ø | Œ | º | ì | í | î | ï |
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PostScript Helvetica (psh)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | þ | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | ° | – | † | ‡ |
| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | É | ˚ | ¸ | Ì | ˝ | ˛ | ˇ | — | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û |
| 22 | Ü | Ý | Þ | ß | à | Æ | â | ª | ä | å | æ | ç | Ł | Ø | Œ | º | ì | í | î | ï |
| 24 | ð | æ | ò | ó | ô | ı | ö | ÷ | ł | ø | œ | ß | ü | ý | þ | ÿ | | | | |

PostScript Helvetica-Bold (pshb)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | þ | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | ° | – | † | ‡ |
| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | É | ˚ | ¸ | Ì | ˝ | ˛ | ˇ | — | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û |
| 22 | Ü | Ý | Þ | ß | à | Æ | â | ª | ä | å | æ | ç | Ł | Ø | Œ | º | ì | í | î | ï |
| 24 | ð | æ | ò | ó | ô | ı | ö | ÷ | ł | ø | œ | ß | ü | ý | þ | ÿ | | | | |

PostScript Helvetica-BoldOblique (pshbo)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | þ | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | ° | – | † | ‡ |
| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | É | ˚ | ¸ | Ì | ˝ | ˛ | ˇ | — | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û |
| 22 | Ü | Ý | Þ | ß | à | Æ | â | ª | ä | å | æ | ç | Ł | Ø | Œ | º | ì | í | î | ï |
| 24 | ð | æ | ò | ó | ô | ı | ö | ÷ | ł | ø | œ | ß | ü | ý | þ | ÿ | | | | |

PostScript Helvetica-Oblique (psho)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | þ | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | ° | – | † | ‡ |
| 18 | · | µ | ¶ | • | ‚ | „ | ” | » | … | ‰ | ¾ | ¿ | À | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | É | ˚ | ¸ | Ì | ˝ | ˛ | ˇ | — | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û |
| 22 | Ü | Ý | Þ | ß | à | Æ | â | ª | ä | å | æ | ç | Ł | Ø | Œ | º | ì | í | î | ï |
| 24 | ð | æ | ò | ó | ô | ı | ö | ÷ | ł | ø | œ | ß | ü | ý | þ | ÿ | | | | |

PostScript Helvetica-Condensed (pshc)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript Helvetica-Condensed-Bold (pshcb)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript Helvetica-Condensed-BoldOblique (pshcdo

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript Helvetica-Narrow (pshn)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript Helvetica-Narrow-Bold (pshnb)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
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PostScript Helvetica-Narrow-BoldOblique (pshnbo)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
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| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript Helvetica-NarrowOblique (pshno)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript NewCenturySchlbk-Bold (psncsb)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript NewCenturySchlbk-BoldItalic (psncsbi)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ¡ | ¢ | £ | ⁄ | ¥ | ƒ | § | ¤ | ' | “ | « | ‹ | › | ﬁ | ﬂ | | – | † | ‡ |
| 18 | · | | ¶ | • | ‚ | „ | ” | » | … | ‰ | | ¿ | | ` | ´ | ˆ | ˜ | ¯ | ˘ | ˙ |
| 20 | ¨ | | ˚ | ¸ | | ˝ | ˛ | ˇ | — | | | | | | | | | | | |
| 22 | | | | | | Æ | | ª | | | | | Ł | Ø | Œ | º | | | | |
| 24 | | æ | | | | ı | | | ł | ø | œ | ß | | | | | | | | |

PostScript NewCenturySchlbk-Italic (psncsi)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | ! | " | # | $ | % | & | ’ |
| 4 | ( | ) | * | + | , | - | . | / | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; |
| 6 | < | = | > | ? | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ | ‘ | a | b | c |
| 10 | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w |
| 12 | x | y | z | { | \| | } | ~ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
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PostScript NewCenturySchlbk-Roman (psncsr)

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PostScript Palatino-Bold (pspb)

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PostScript Palatino-BoldItalic (pspbi)

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PostScript Palatino-Italic (pspi)

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PostScript Palatino-Roman (pspr)

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PostScript Symbol (pssym)

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| 10 | δ | ε | ϕ | γ | η | ι | φ | κ | λ | μ | ν | ο | π | θ | ρ | σ | τ | υ | ϖ | ω |
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| 20 | ∪ | ⊃ | ⊇ | ⊄ | ⊂ | ⊆ | ∈ | ∉ | ∠ | ∇ | ® | © | ™ | ∏ | √ | ⋅ | ¬ | ∧ | ∨ | ⇔ |
| 22 | ⇐ | ⇑ | ⇒ | ⇓ | ◊ | 〈 | ® | © | ™ | ∑ | ⎛ | ⎜ | ⎝ | ⎡ | ⎢ | ⎣ | ⎧ | ⎨ | ⎩ | ⎪ |
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PostScript Times-Bold (pstb)

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PostScript Times-BoldItalic (pstbi)

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| 8 | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | ¯ | ‘ | a | b | c |
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PostScript Times-Italic (psti)

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PostScript Times-Roman (pstr)

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PostScript ZapfChancery-MediumItalic (pszcmi)

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| 14 | | | | | | | | | | | | | | | | | | | | |
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PostScript ZapfDingbats (pszd)

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| 2 | | | | | | | | | | | | | | ✁ | ✂ | ✃ | ✄ | ☎ | ✆ | ✇ |
| 4 | ✈ | ✉ | ☛ | ☞ | ✌ | ✍ | ✎ | ✏ | ✐ | ✑ | ✒ | ✓ | ✔ | ✕ | ✖ | ✗ | ✘ | ✙ | ✚ | ✛ |
| 6 | ✜ | ✝ | ✞ | ✟ | ✠ | ✡ | ✢ | ✣ | ✤ | ✥ | ✦ | ✧ | ★ | ✩ | ✪ | ✫ | ✬ | ✭ | ✮ | ✯ |
| 8 | ✰ | ✱ | ✲ | ✳ | ✴ | ✵ | ✶ | ✷ | ✸ | ✹ | ✺ | ✻ | ✼ | ✽ | ✾ | ✿ | ❀ | ❁ | ❂ | ❃ |
| 10 | ❄ | ❅ | ❆ | ❇ | ❈ | ❉ | ❊ | ❋ | ● | ❍ | ■ | ❏ | ❐ | ❑ | ❒ | ▲ | ▼ | ◆ | ❖ | ◗ |
| 12 | ❘ | ❙ | ❚ | ❛ | ❜ | ❝ | ❞ | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | |
| 16 | | ❡ | ❢ | ❣ | ❤ | ❥ | ❦ | ❧ | ♣ | ♦ | ♥ | ♠ | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ |
| 18 | ⑨ | ⑩ | ❶ | ❷ | ❸ | ❹ | ❺ | ❻ | ❼ | ❽ | ❾ | ❿ | ➀ | ➁ | ➂ | ➃ | ➄ | ➅ | ➆ | ➇ |
| 20 | ➈ | ➉ | ➊ | ➋ | ➌ | ➍ | ➎ | ➏ | ➐ | ➑ | ➒ | ➓ | ➔ | → | ↔ | ↕ | ➘ | ➙ | ➚ | ➛ |
| 22 | ➜ | ➝ | ➞ | ➟ | ➠ | ➡ | ➢ | ➣ | ➤ | ➥ | ➦ | ➧ | ➨ | ➩ | ➪ | ➫ | ➬ | ➭ | ➮ | ➯ |
| 24 | | ➱ | ➲ | ➳ | ➴ | ➵ | ➶ | ➷ | ➸ | ➹ | ➺ | ➻ | ➼ | ➽ | ➾ | | | | | |

## A.7 Predefined Colors

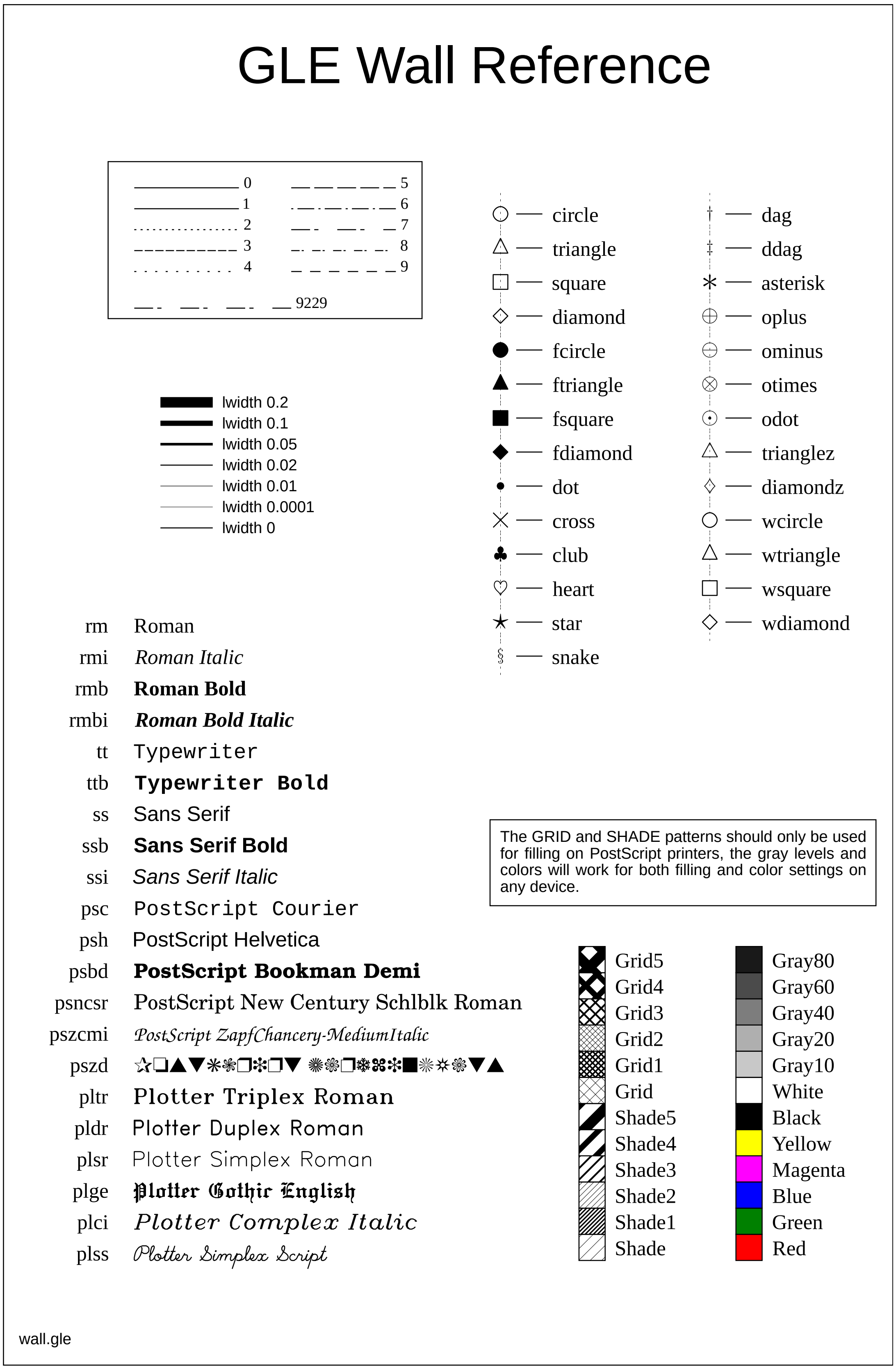
GLE supports these SVG/X11 standard colors (sorted by color)

| | | | |
|---|---|---|---|
| indianred | mediumpurple | darkturquoise | azure |
| lightcoral | blueviolet | cadetblue | aliceblue |
| salmon | darkviolet | steelblue | ghostwhite |
| darksalmon | darkorchid | lightsteelblue | whitesmoke |
| lightsalmon | darkmagenta | powderblue | seashell |
| crimson | purple | lightblue | beige |
| red | indigo | skyblue | oldlace |
| firebrick | slateblue | lightskyblue | floralwhite |
| darkred | darkslateblue | deepskyblue | ivory |
| pink | greenyellow | dodgerblue | antiquewhite |
| lightpink | chartreuse | cornflowerblue | linen |
| hotpink | lawngreen | mediumslateblue | lavenderblush |
| deeppink | lime | royalblue | mistyrose |
| mediumvioletred | limegreen | blue | gainsboro |
| palevioletred | palegreen | mediumblue | lightgray |
| coral | lightgreen | darkblue | silver |
| tomato | mediumspringgreen | navy | darkgray |
| orangered | springgreen | midnightblue | gray |
| darkorange | mediumseagreen | cornsilk | dimgray |
| orange | seagreen | blanchedalmond | lightslategray |
| gold | forestgreen | bisque | slategray |
| yellow | green | navajowhite | darkslategray |
| lightyellow | darkgreen | wheat | black |
| lemonchiffon | yellowgreen | burlywood | gray1 |
| lightgoldenrodyellow | olivedrab | tan | gray5 |
| papayawhip | olive | rosybrown | gray10 |
| moccasin | darkolivegreen | sandybrown | gray20 |
| peachpuff | mediumaquamarine | goldenrod | gray30 |
| palegoldenrod | darkseagreen | darkgoldenrod | gray40 |
| khaki | lightseagreen | peru | gray50 |
| darkkhaki | darkcyan | chocolate | gray60 |
| lavender | teal | saddlebrown | gray70 |
| thistle | aqua | sienna | gray80 |
| plum | cyan | brown | gray90 |
| violet | lightcyan | maroon | |
| orchid | paleturquoise | white | |
| fuchsia | aquamarine | snow | |
| magenta | turquoise | honeydew | |
| mediumorchid | mediumturquoise | mintcream | |

GLE supports these SVG/X11 standard colors (alphabetical order)

| | | | |
|---|---|---|---|
| aliceblue | deepskyblue | linen | salmon |
| antiquewhite | dimgray | magenta | sandybrown |
| aqua | dodgerblue | maroon | seagreen |
| aquamarine | firebrick | mediumaquamarine | seashell |
| azure | floralwhite | mediumblue | sienna |
| beige | forestgreen | mediumorchid | silver |
| bisque | fuchsia | mediumpurple | skyblue |
| black | gainsboro | mediumseagreen | slateblue |
| blanchedalmond | ghostwhite | mediumslateblue | slategray |
| blue | gold | mediumspringgreen | snow |
| blueviolet | goldenrod | mediumturquoise | springgreen |
| brown | gray | mediumvioletred | steelblue |
| burlywood | green | midnightblue | tan |
| cadetblue | greenyellow | mintcream | teal |
| chartreuse | honeydew | mistyrose | thistle |
| chocolate | hotpink | moccasin | tomato |
| coral | indianred | navajowhite | turquoise |
| cornflowerblue | indigo | navy | violet |
| cornsilk | ivory | oldlace | wheat |
| crimson | khaki | olive | white |
| cyan | lavender | olivedrab | whitesmoke |
| darkblue | lavenderblush | orange | yellow |
| darkcyan | lawngreen | orangered | yellowgreen |
| darkgoldenrod | lemonchiffon | orchid | gray1 |
| darkgray | lightblue | palegoldenrod | gray5 |
| darkgreen | lightcoral | palegreen | gray10 |
| darkkhaki | lightcyan | paleturquoise | gray20 |
| darkmagenta | lightgoldenrodyellow | palevioletred | gray30 |
| darkolivegreen | lightgray | papayawhip | gray40 |
| darkorange | lightgreen | peachpuff | gray50 |
| darkorchid | lightpink | peru | gray60 |
| darkred | lightsalmon | pink | gray70 |
| darksalmon | lightseagreen | plum | gray80 |
| darkseagreen | lightskyblue | powderblue | gray90 |
| darkslateblue | lightslategray | purple | |
| darkslategray | lightsteelblue | red | |
| darkturquoise | lightyellow | rosybrown | |
| darkviolet | lime | royalblue | |
| deeppink | limegreen | saddlebrown | |

## A.8 Wall Reference



The GRID and SHADE patterns should only be used for filling on PostScript printers, the gray levels and colors will work for both filling and color settings on any device.

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